S
628.168
M26mrs
1989
Milltown Reservoir sediments CERCLA site feasibility study work plan scoping document, Milltown, Montana

FINAL

STATE DOCUMENTS COLLECTION

APR 1 (1989

MONTANA STATE LIBRARY
1515 E. 6th AVE.
HELENA, MONTANA 59620

MILLTOWN RESERVOIR SEDIMENTS CERCLA SITE

WORK PLAN SCOPING DOCUMENT

MILLTOWN, MONTANA

PLEASE RETURN

JANUARY 9, 1989

environmental engineers, scientists, planners, & management consultants
CDM

APR 2 6 1993

JUN 3 2003

DEC 1 5 2005

MONTANA STATE LIBRARY
S 628.168 M26mrs 1989 c.1
Milltown Reservoir sediments CERCLA site
3 0864 00062587 4

MILLTOWN RESERVOIR SEDIMENTS
CERCLA SITE
FEASIBILITY STUDY
WORK PLAN SCOPING DOCUMENT

MILLTOWN, MONTANA

MDHES Contract No.: 800454-TP-01

January 9, 1989

Document Control No.: 8469-WP-F-R0-010989

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1-1
	1.1 Site History	1-1
	1.2 RI/FS Status	1-6
	1.3 Feasibility Study Objectives	1-8
2.0	INITIAL SITE EVALUATION	2-1
	2.1 Site Description	2-1
	2.1.1 Climate	2-1
	2.1.2 Geology	2-2
	2.1.3 Hydrology	2-2
	2.1.4 Sediments	2-5
	2.1.5 Vegetation	2-7
	2.1.6 Wildlife and Aquatic Ecology	2-7
	2.1.7 Demography and Land Use	2-9
	2.1.8 Milltown Dam	2-10
	2.1.9 Community Concerns	2-14
	2.2 Contamination Problem Definition	2-16
	2.2.1 Degree of Metal Contamination	2-17
	2.2.2 Potential Contaminant Pathways and Receptors	2-31
	2.2.3 Environmental and Public Health Effects	2-35
	2.3 Initial Remedial Measures	2-36
	2.3.1 Replacement Water Supply	2-36
	2.3.2 Reservoir Drawdown	2-37
	2.4 Preliminary Identification of Remedial Alternatives	2-37
3.0	WORK PLAN RATIONALE	3-1
4.0	SUPPLEMENTARY SITE INVESTIGATION ACTIVITIES	4-1
	4.1 Task 1.0 - Project Planning	4-1
	4.1.1 Subtask 1.1 - Project Scoping	4-1
	4.1.2 Subtask 1.2 - Health and Safety Plan	4-2
	4.1.3 Subtask 1.3 - Sampling and Analysis Plan	4-3
	4.1.4 Subtask 1.4 - Site Management Plan	4-4
	4.1.5 Subtask 1.5 - Quality Assurance Plan	4-5
	4.1.6 Subtask 1.6 - Data Management Plan	4-6
	4.1.7 Subtask 1.7 - Site Survey	4-7
	4.2 Task 2.0 - Community Relations Support	4-7
	4.2.1 Subtask 2.1 - Community Relations Plan	4-8
	4.2.2 Subtask 2.2 - Public Meetings	4-8
	4.2.3 Subtask 2.3 - Support Activities	4-9

Digitized by the Internet Archive
in 2015

https://archive.org/details/milltownreservo1989unit_0

TABLE OF CONTENTS (cont.)

Section		Page
4.3	Task 3.0 - Inventory of Potentially Protected Resources	4-9
4.3.1	Subtask 3.1 - Cultural Resources Assessment	4-9
4.3.2	Subtask 3.2 - Endangered Species	4-10
4.3.3	Subtask 3.3 - Wetlands Assessment	4-11
4.4	Task 4.0 - Ground Water Investigation	4-11
4.4.1	Subtask 4.1 - Source Characterization	4-12
4.4.2	Subtask 4.2 - Plume Delineation	4-15
4.4.3	Subtask 4.3 - Hydrogeologic and Geochemical Characterization	4-19
4.4.4	Subtask 4.4 - Recharge/Discharge Relationships..	4-23
4.4.5	Subtask 4.5 - Receptors	4-25
4.4.6	Subtask 4.6 - Background Water Quality	4-29
4.5	Task 5.0 - Surface Water Investigation	4-30
4.5.1	Subtask 5.1 - Characterization of the Surface Water Regime	4-31
4.5.2	Subtask 5.2 - Sediment Transport Characterization	4-33
4.5.3	Subtask 5.3 - Recharge/Discharge Relationships .	4-39
4.5.4	Subtask 5.4 - Surface Water Receptors	4-41
4.5.5	Subtask 5.5 - Background Surface Water Quality .	4-42
4.6	Task 6.0 - Reservoir Sediments Investigation	4-42
4.7	Task 7.0 - Data Validation	4-43
4.7.1	Subtask 7.1 - Validation of Analytical Data	4-44
4.7.2	Subtask 7.2 - Validation of Field Measurement Data	4-44
4.7.3	Subtask 7.3 - Reporting	4-44
4.8	Task 8.0 - Preliminary Site Characterization Summary ..	4-44
4.9	Task 9.0 - Supplemental Site Investigation Activities Report	4-45
5.0	FEASIBILITY STUDY ACTIVITIES	5-1
5.1	Task 10.0 - Endangerment Assessment/Action Levels	5-1
5.1.1	Subtask 10.1 - Public Health Evaluation	5-1
5.1.2	Subtask 10.2 - Environmental Assessment	5-3
5.1.3	Subtask 10.3 - Action Levels/Cleanup Goals Memorandum	5-4
5.2	Task 11.0 - ARARs Analysis	5-5
5.3	Task 12.0 - Remedial Alternatives Screening	5-36
5.4	Task 13.0 - Remedial Alternatives Evaluation	5-39
5.5	Task 14.0 - Feasibility Study Report	5-43
6.0	SCHEDULE	6-1
7.0	REFERENCES	7-1

TABLE OF CONTENTS (cont.)

APPENDICES

A - Preliminary Endangerment Assessment
B - Data Evaluation Report
C - Chemical Data for Sediment and Core Samples; Location Maps
D - ARARs Analysis

LIST OF TABLES

Table		Page
2-1	Selected Surface Water Quality Measurements - Milltown Vicinity	2-18
2-2	Sediment Quality in Grab Samples - Milltown Reservoir Sediment	2-23
2-3	Pore Water Quality	2-24
2-4	Mean Sediment Quality of Core Samples - Milltown Reservoir Sediment	2-26
2-5	Concentrations of Heavy Metals in Sediment Pore Water and Ground Waters at, and Adjacent to, Milltown Reservoir	2-28
2-6	Range in Actual Concentrations and Suggested Critical Plant and Maximum Tolerable Dietary Levels for As, Cd, Cu, Mn, Pb, and Zn for Vegetation Samples Collected from Milltown Reservoir	2-32
2-7	Contaminants of Primary Concern at the Milltown, Montana Site and Possible ARAR-Defined Levels	2-33
3-1	Information Needs Summary - Ground Water	3-5
3-2	Information Needs Summary - Surface Water	3-7
3-3	Information Needs Summary - Sediment	3-10
3-4	Information Needs Summary - Public Health	3-11
3-5	Information Needs Summary - Environmental Assessment	3-13
3-6	Information Needs Summary - Alternative Development	3-15
4-1	Ground Water Analyses	4-18
4-2	Surface Water Analyses	4-38
5-1	Summary of Montana Applicable and/or Relevant and Appropriate Requirements	5-10
5-2	Potentially Applicable or Relevant and Appropriate Contaminant-Specific Federal Standards, Requirements, Criteria, and Limitations	5-25
5-3	Potentially Applicable or Relevant and Appropriate Location-Specific Federal Standards, Requirements, Criteria, and Limitations	5-27
5-4	Potentially Applicable or Relevant and Appropriate Action-Specific Federal Standards, Requirements, Criteria, and Limitations	5-30

LIST OF FIGURES

Figure		Page
1-1	Site Location Map	1-3
1-2	Milltown Site Vicinity Map	1-5
4-1	Proposed Groundwater Monitoring Program	4-17

1.0 INTRODUCTION

The Milltown Reservoir Sediments site is a National Priority List site characterized by uncontrolled metal and metalloid contamination of reservoir sediments and attendant potential risks to human health and the environment. In compliance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA), this Feasibility Study Work Plan Scoping Document has been developed under a cooperative agreement between the Montana Department of Health and Environmental Sciences and the United States Environmental Protection Agency.

The Scoping Document provides an initial assessment of work tasks and information requirements for completion of a Feasibility Study that will support the selection of a final remedy for this site. The Scoping Document will support discussion between the Montana Department of Health and Environmental Science (MDHES), the Environmental Protection Agency (EPA), and potentially responsible parties (PRPs) regarding the acceptability and use of existing site-specific and regional data for the purposes of the Feasibility Study. Final information requirements, and the scope of the Feasibility Study, will be determined on the basis of the scoping process.

1.1 SITE HISTORY

Milltown Dam was constructed in 1906-1907 to provide hydroelectric power. Since the construction of Milltown Dam, the reservoir has accumulated a large volume of sediment. Contaminated sediments in the reservoir have been derived from mining activities in the vicinity of Butte, Montana, and mining related activities (milling, processing, etc.) in Butte and downstream regions, including Anaconda. These sediments have been determined to be the source of both surface water and ground water contamination in the area (CDM, 1986 and Woessner et al., 1984).

The Milltown Reservoir CERCLA site is adjacent to the Town of Milltown and is located approximately 5 miles east of Missoula, Montana (Figure 1-1) at the confluence of the Clark Fork and Blackfoot rivers. Available historical information indicates the town was founded sometime around 1907-1908 to house employees of the new lumber mill at the site, which was constructed by W.A. Clark. The area had been an important wood products center since 1885 when the Blackfoot Milling and Manufacturing plant was built in the adjacent town of Bonner. The Champion International mill currently operates in Milltown producing plywood and other wood products.

A dam was constructed in 1906 and 1907 immediately downstream of the confluence of the Clark Fork and Blackfoot Rivers to provide hydroelectric power to the mill and to Missoula. The dam was constructed using rock filled timber cribs housing five turbine generator units. During the flood of 1908, which reportedly produced a discharge of 50,000 cubic feet per second at Missoula, a portion of the dam was destroyed by dynamiting in order to save the structure from total failure. The dam was repaired and has been in continual operation since 1908. The reservoir created by the dam covers about 180 acres and appears as only a slight widening in the Clark Fork and Blackfoot River channels.

Since 1908, the reservoir has been subject to considerable sediment accumulation. The Clark Fork River drains an area of approximately 3,710 square miles of intensively mined land above Milltown and has a large capacity for sediment transport. The Blackfoot River drains 2,290 square miles with no mining induced contamination detected. Woessner et al. (1984) have estimated that 29 feet of sediment are present at the upstream face of the dam and that the reservoir contains about 120 million cubic feet (2,750 acre-feet) of sediment. This accumulation has reduced the storage capacity of the reservoir over the years to its present estimated value of 820 acre-feet at the normal operating level (Curtis, 1985).

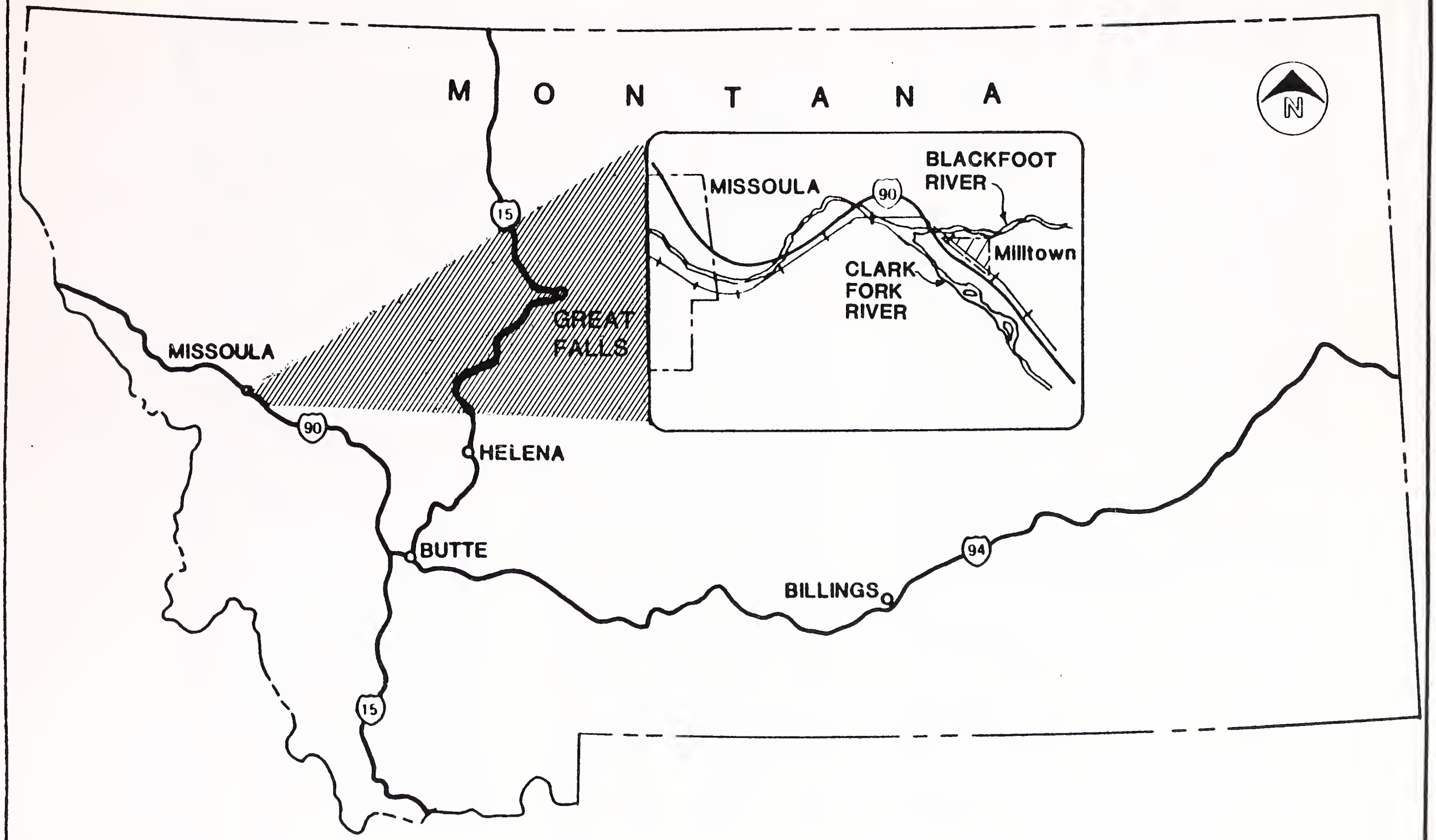


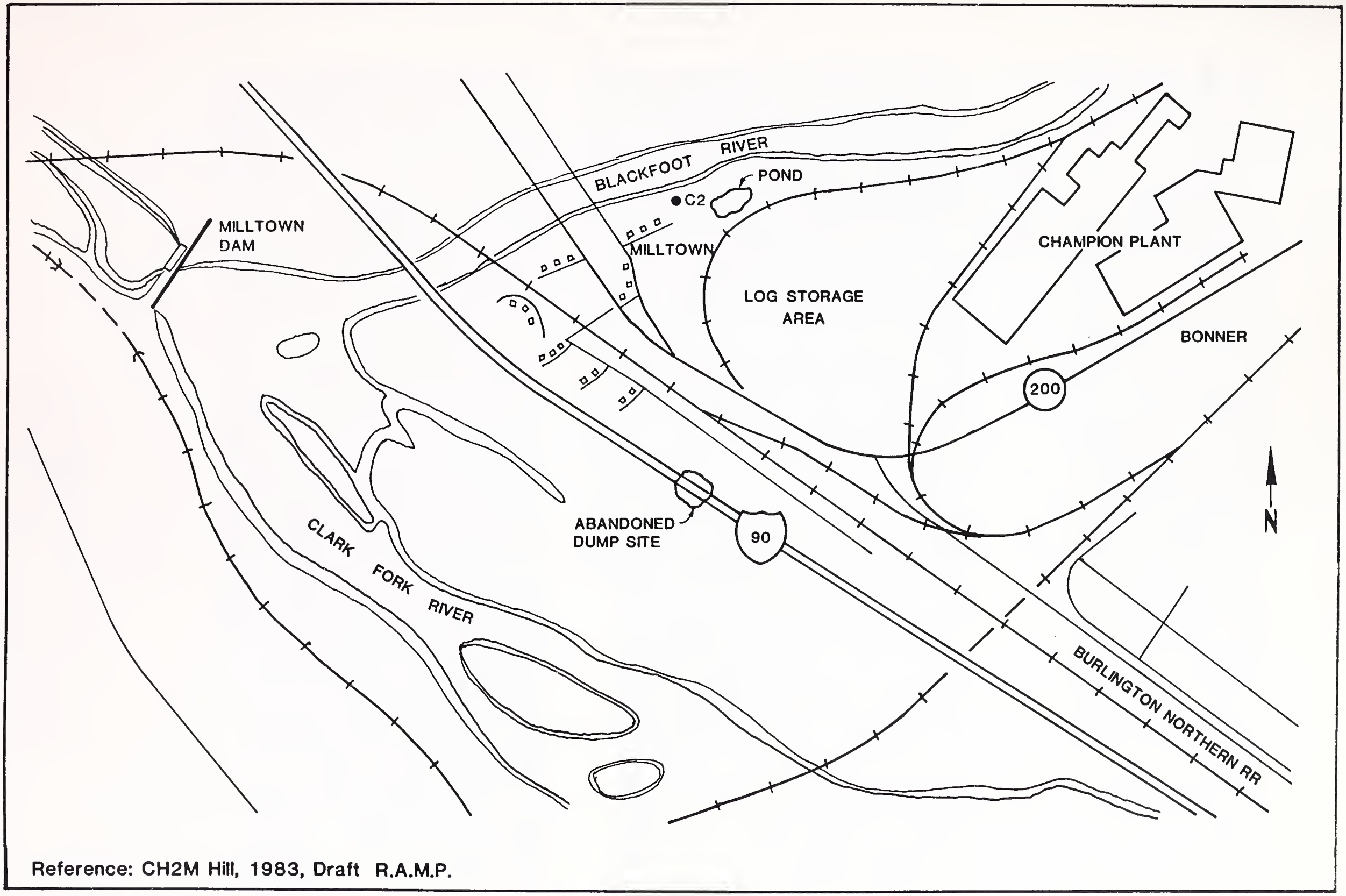
Figure 1-1 Site Location Map

Reference: CH2M Hill, 1983, Draft R.A.M.P.

The current situation in Milltown is tied to historic events that occurred upstream of the Milltown Dam and Reservoir. The Clark Fork River Basin has been the setting for mining activity since at least 1864, when gold was discovered at Butte. By 1881, Butte was an important mining, milling, and smelting center. At least 25 companies were mining copper ore at Butte in 1885 (Montana Department of State Lands, 1981). Although Butte and Anaconda were the primary mining centers, other smaller mining districts were active as well. General disregard of environmental effects of mining during this period led to disposal of ore, tailings, milling byproducts, and smelting wastes directly into rivers and streams tributary to the Clark Fork. These wastes, containing concentrated arsenic, lead, cadmium, zinc, copper, and iron, were added to the normal sediment load of the Clark Fork and transported down river to the settling basin created by the Milltown Dam.

The water supply for Milltown has been supplied by water wells since the first recorded well was drilled in 1908 (CH2M Hill, 1983). In 1975, several wells were contaminated by a spill or leakage of log sprinkling water held in a temporary pond at the Champion Plant. The affected wells were sampled in June, 1975 by the Montana Department of Health and Environmental Sciences (MDHES) and were found to have high concentrations of tannins and lignins; metals were not analyzed at this time. Well C-2 (Figure 1-2) was constructed in the fall of 1975 by Champion to replace the wells contaminated with organics (CH2M Hill, 1983).

Well C-2 was sampled on September 14, 1977 under a program by the Montana Water Quality Bureau and was found to be uncontaminated (containing less than 0.001 mg/1 arsenic). Under this program, wells were to be sampled every three years; therefore, water samples of four community wells were taken on May 18, 1981. The analyses showed arsenic at concentrations ranging from 0.22 to 0.51 mg/1, far above the maximum 0.05 mg/1 level in Primary Drinking Water Regulations (EPA, 1976). Residents whose wells were affected were asked to stop using the water on August 20, 1981. Alternative water supply and distribution systems were evaluated in a



Reference: CH2M Hill, 1983, Draft R.A.M.P.

Figure 1-2 Milltown Site Vicinity Map

feasibility study (Peccia, 1983) and a Record of Decision (ROD) was executed by EPA on April 14, 1984, implementing the replacement of those wells contaminated with arsenic. A replacement well was constructed adjacent to Well C-2 in 1984. A supplemental Record of Decision was executed on August 7, 1985 that implemented decisions regarding the water distribution system and monitoring of household water supplies.

1.2 RI/FS STATUS

A reconnaissance level hydrologic investigation was initiated in February 1982 (Woessner and Popoff, 1982) which identified the reservoir sediments as a potential source of the arsenic and other metals including iron, lead, manganese, and zinc. The EPA ranked the Milltown site as number 200 out of the initial 400 NPL sites as a result of this initial study. An additional investigation was begun in July, 1983 to more thoroughly investigate the ground water contamination problem and to identify an alternative water supply for the affected residences. The remedial investigation was completed in July 1984 (Arsenic Source and Water Supply Remedial Action Study, Woessner et al., 1984) and the alternative water supply well and distribution system was evaluated (Peccia, 1983) and installed in October 1984 adjacent to the Champion replacement well.

The 1982 reconnaissance study by Woessner and Popoff and the 1984 study by Woessner et al. together comprise the Remedial Investigation (RI) for the Milltown Reservoir Sediment site. Supplemental field investigations were undertaken in 1985 and 1986 by Harding Lawson Associations (HLA) under contract to MDHES. The purpose of this investigation was to fill data needs for development, screening, and analysis of alternatives for the Feasibility Study (FS). The scope of HLA's investigation focused on sediment and ground water issues and excluded downstream areas. The HLA studies are documented in a draft FS and in a draft data report submitted to MDHES in 1987 (HLA, 1986 and 1987, respectively).

MDHES and HLA recognized that additional data needs would not be addressed by the studies undertaken in 1985 and 1986 (see Section 1.3 of HLA, 1987). In particular, information characterizing the surface water systems and aquatic life, sediment-hydrologic properties, a public health evaluation, downgradient ground water quality, wildlife, vegetation, and potential receptors was considered to be inadequately addressed by the scope of HLA's field investigations. The laboratory data developed by HLA was submitted in 1987 without adequate documentation to verify compliance with EPA Region VIII quality assurance criteria (EPA, 1985a). Later submittals are under review; however, it is assumed in this Work Plan that all HLA laboratory data will eventually be supported by adequate quality assurance documentation and found to be acceptable.

Camp Dresser & McKee (CDM) received EPA Work Assignment No 81-8L23 in March, 1985. This assignment provided for interim work tasks to assist the Environmental Protection Agency (EPA) and the State of Montana in initiating the Milltown Feasibility Study overseeing replacement of the water supply, and validating the data of Woessner et al. (1984). The result was an Interim Report (CDM, 1986) which included a Preliminary Endangerment Assessment (PEA). The PEA is reprinted as Appendix A herein.

The present Work Plan Scoping Document is intended to address all data deficiencies that are currently recognized for the purpose of development of the FS in addition to insuring the development of a complete document, in compliance with CERCLA and State law. Because of the availability of significant data from a variety of sources, the anticipated Work Plan scope is based on a review of key data sources (Appendix B) with particular reference to a working list of potential remedial alternatives (Section 2.4) and applicable and relevant and appropriate State and Federal requirements (ARARs) specific to the Milltown location, contemplated actions, and contaminants of concern.

1.3 FEASIBILITY STUDY OBJECTIVES

This Scoping Document describes the tasks to be performed for a Feasibility Study (FS) of the Milltown Reservoir Sediments site consistent with EPA's National Contingency Plan (NCP) (40 CFR Part 300), CERCLA, and the Superfund Amendments Reauthorization Act (SARA). The FS will evaluate the study area with respect to present and future contamination of ground and surface water.

The objectives of the FS are to identify and evaluate alternatives for remediation of site-related contamination based on data gathered during the RI and supplemental field investigations and to recommend a site cleanup plan. Based on the FS, a final remedy will be selected by MDHES and EPA. The central objectives of the FS remedy selection are as follows:

Objective 1: Minimize Downstream Contaminant Releases

There are two potential pathways whereby contaminants currently present in the reservoir could be released downstream. First, dissolved species in the ground water plume transported downgradient of the reservoir could contaminate water supply wells or enter the surface water system downstream of Milltown Dam. The second pathway consists of dissolved/suspended species moving within the surface water of the Clark Fork River particularly under high flow or reservoir drawdown conditions. The specific response objectives proposed for these two conditions are:

- Meet ARARs, be protective of human health and the environment and address other requirements of Section 121 of CERCLA.
- Restrict the release of contaminants such that they do not reduce the beneficial use of the downgradient surface water or ground water and such that they do not reduce or limit the diversity or abundance of aquatic life downstream of the reservoir.

Objective 2: Minimize Ingestion of Contaminants

There are five major pathways whereby the human and animal populations of Milltown and the surrounding areas can consume contaminants originating at the Milltown site:

1. Ingestion of contaminated ground water,
2. Ingestion of contaminated surface water,
3. Ingestion of contaminated aquatic organisms,
4. Ingestion of contaminated vegetation, and
5. Direct ingestion of contaminated soils/sediments.

The specific response objective proposed for these conditions is:

- o Meet ARARs
- o Restrict the total consumption of heavy metals (As, Cd, Cu, Fe, Pb, Mn, and Zn) to acceptable levels.

2.0 INITIAL SITE EVALUATION

As background for understanding the scope of FS Work Plan requirements, the following sections describe site limits, geology, ground water and surface water hydrology, sediments, ecological characteristics, land use, and community concerns regarding the contamination problem at Milltown Dam and Reservoir. The contamination problem is defined against this background.

2.1 SITE DESCRIPTION

The Milltown site lies within the Northern Rocky Mountains physiographic province in western Montana. Three mountain ranges intersect in the vicinity of Milltown: the Mission Range, which extends northward from Milltown; the Sapphire Mountains, which extend southward; and the Garnet Range, which separates the Clark Fork and Blackfoot Rivers. The topography is mountainous with associated steep-sided river valleys, typified by the Clark Fork. Elevations range from 3,260 feet at the reservoir to 6,813 feet at Bonner Mountain, located to the east of Milltown. The Clark Fork River gradient ranges from 10 to 15 feet per mile; gradient on the Blackfoot River is about 20 feet per mile.

Major drainages in the basin above the Milltown dam include the Clark Fork, Flint Creek, Rock Creek, Clearwater River, Blackfoot River, and Little Blackfoot River (Figure 1-1).

2.1.1 CLIMATE

The study area has a semi-arid climate with an average annual precipitation of 13 inches. May and June are the wettest months and March the driest. Temperatures average 22.7° F during January, the coldest month, and 71.8° F during July, the warmest month. During January or February, subarctic air from Canada occasionally spills over the continental divide 55 miles to the

northeast and sweeps through the valley with resulting sub-zero temperatures. Moist Pacific air dominates the climate most of the year (Woessner et al., 1984).

2.1.2 GEOLOGY

Milltown, located in the valley of the Clark Fork, is underlain by deposits of Quaternary alluvium which range in thickness from 65 feet under Milltown Dam to 155 feet in the vicinity of the Champion (Bonner) Mill. The alluvium consists of interbedded sand and gravel with clay lenses. The valley floor and the surrounding mountains are comprised of Precambrian age metasediments of the Belt Series. Metamorphic rock types which outcrop in the vicinity of Milltown include argillite and quartzite, several igneous dikes and sills are also present. Other rock types which outcrop in the area include limestone. The metasediments are folded into roughly northwest-trending anticlines and synclines, which are often structurally complex due to overturning and thrust faulting. Recent reservoir sediments reach a thickness of 29 feet at the Milltown Dam (Woessner et al., 1984). Lithologies range from fine sand and silt to medium sands with clay lenses.

Numerous faults cut the complex geology of the area. Although obscured by alluvium, the Clark Fork Fault trends along the river valley (Nelson and Dobell, 1961), passes under the dam, and outcrops on Jumbo Mountain east of the site. The Blackfoot Thrust Fault similarly roughly parallels the Blackfoot River and intersects the Clark Fork Fault in the vicinity of the reservoir.

2.1.3 HYDROLOGY

Ground Water

The ground water hydrology of the Milltown site is dominated by the permeable alluvial deposits of the Clark Fork and Blackfoot Rivers. The bedrock units underlying the alluvium have extremely low primary porosities

and when fresh are considered water-bearing units only if fractured. Woessner et al. (1984) report highly weathered bedrock below alluvium at two drilling sites which produced an estimated 50 to 100 gallons per minute of water. Although much less than the yield from the alluvial aquifer, this is a significant amount of ground water. Tritium and deuterium analyses reported by Woessner et al. (1984) show that ground water from the alluvium and from the bedrock have the same isotopic signature, indicating a similar meteoric origin for both, although the water chemistries of each are different. Thus, the alluvium and the upper weathered bedrock can be considered one hydrologic system.

The water table in the alluvium ranges from 32 to 75 feet below ground surface in the vicinity of Milltown, based on a network of 26 wells installed by Woessner et al. (1984). Sand points installed by Woessner et al. (1984) in the unsubmerged reservoir sediments revealed a water table several feet below the reservoir water elevation. Ground water in the alluvium is recharged by the rivers and the reservoir, resulting in movement of ground water generally to the southwest, parallel to the two river channels, with an added flow component generally northwestward and northward, away from the reservoir. These flow paths merge in the vicinity of the contaminated wells and continue generally westward parallel to the Clark Fork below Milltown. During high reservoir stages, a component of flow exists from the reservoir sediments into the alluvium. However, during lower reservoir stages, ground water could flow both to the reservoir and the alluvial aquifer to the north. Steep downward gradients of 0.5 to 1.0 ft/ft are present in the reservoir sediments, while flow in the alluvium is essentially horizontal with vertical gradients of 0.001 to 0.008 ft/ft (Woessner et al., 1984).

Transmissivities of the alluvium measured by Woessner et al. (1984) range from 170 to 13,000 ft^2/day with velocities of between 0.17 to 2.0 ft/day. Based on these values, estimates of the flux moving through the alluvium in the vicinity of Milltown range from 1.25 million ft^3/day (CDM, 1986) to 2.2

million ft^3/day (Woessner et al., 1984). These values are seasonal, and tend to vary in response to river stage.

Surface Water

The primary surface water bodies in the Milltown vicinity are the Clark Fork and Blackfoot Rivers. The 43 year average discharge at USGS gaging station number 123400000 on the Blackfoot River, eight miles north of Milltown, is 1,653 ft^3/second. Over the period of record, the maximum discharge, recorded on June 10, 1964 was 19,200 ft^3/second; the minimum, recorded on January 4, 1950, was 200 ft^3/second. USGS measurements performed during the current water year (1988) indicate that the minimum flow of record will remain at 200 cfs; however, due to the low flow conditions present, it is possible that lower flows may occur during the winter of 1989 once the river ices over (USGS, September 29, 1988). The drainage area at this station is 2,290 square miles.

Water quality of the Blackfoot River is considered good. Dissolved oxygen is adequate, total dissolved solids are generally around 150 mg/l, sulfates are less than 10 mg/l, and dissolved and total heavy metals are very low or nondetectable. Although some mining occurred in the upper watershed of the Blackfoot, the impact of acid mine drainage and heavy metals on the river is minimal at its lower reach. The Blackfoot is estimated to transport approximately 100,000 tons of suspended sediment per year at its lower reach (CDM, 1986).

The average discharge of the Clark Fork as measured at USGS station 123405000, 2.8 miles downstream of the Dam, is 3,020 ft^3/second. Over the period of record from March 1929 to 1979, maximum discharge was 32,300 ft^3/second measured on June 21, 1975. The flood of 1908, which occurred before the gage was installed, has been estimated at 48,000 ft^3/second by the Montana Power Company. Minimum flow was 340 ft^3/second on September 27, 1937. As on the Blackfoot River, the minimum flow of record will remain

at 340 cfs for the current water year (USGS, September 29, 1988). Drainage area at this station, including the Blackfoot River basin, is 5,999 square miles.

Sole Source Aquifer Petition

In 1988, the Missoula City-County Health Department petitioned the EPA to designate the Missoula Aquifer a "Sole Source Aquifer" as provided for in the Federal Safe Drinking Water Act Amendments of 1986 (42 USC 300f as amended by PL 99-339, June 1986). EPA designated the Missoula Aquifer as a Sole Source Aquifer in May, 1988. The Milltown Reservoir Sediments site is up-gradient of the Missoula Aquifer.

The boundaries of the aquifer lie completely within Missoula County. County population is 77,400. The Missoula Aquifer is currently the only source of drinking water for Missoula Valley residents and supplies 80 percent of the residents in Missoula County with drinking water. The remainder of the County residents live outside the Missoula Valley and receive their drinking water from a variety of surface and ground water sources.

2.1.4 SEDIMENTS

Recent estimates (HLA, 1986) indicate that the reservoir contains 6.6 million yards of contaminated fine-grained sediments (as compared to 4.4 million estimated by Woesner et al. (1984)). This represents over 80 percent of the estimated initial storage capacity of the reservoir. It should be noted that the upstream extent of these sediments has not been identified. Borings at the upstream end of the reservoir found sediment thicknesses of 3 to 4 feet.

The Remedial Investigation (RI), performed in 1983 and 1984 (Woessner et al; 1984), characterized the reservoir sediments in the upper 5 feet only. A total of 34 grab samples and 6 sediment cores were collected and analyzed

by Woessner et al. (1984). The core samples indicate a complex lenticular depositional environment within the reservoir and river channels. In general, the grab samples were comprised of 31 percent sand, 52 to 58 percent silt, 10 to 16 percent clay, and 2 percent organic carbon. The Clark Fork arm of the reservoir has slightly less silt and more clay than the Blackfoot arm. These are mean values and the samples show tremendous variation based on their location within the reservoir. As expected, the river channel bottom contains coarser sediments than the swampy side channel areas, or sloughs.

The sediment cores were driven into the reservoir bottom from 1.25 feet to 6 feet in the RI and are representative only of the uppermost portion the sediment mass. The upper 6 to 16 inches of the cores were light brown in color and oxidized; sediment below was gray and reduced. The cores revealed a complex stratigraphy that showed evidence of scour, reworking, and redeposition. No correlation could be accomplished between cores with the exception of several distinct gray clayey layers. These layers also appeared in outcrop on exposed banks of the reservoir. Woessner et al. (1984) believe the gray layers are the wastes from quartz-mica porphrys mined in Butte and transported to the reservoir during high flow events. Grain-size distribution, though highly variable spatially, does not appear to vary with depth as reported by MPC (Curtis, 1985). In general, cores down to 20 feet depth contained 40 to 95 percent sand, 5 to 50 percent silt, and 1 to 20 percent clay.

The bulk mineralogy of the sediments was dominated by about 60 percent quartz, 12 percent plagioclase feldspar, 6 percent potassium feldspar, and 5 percent calcite. The remaining 17 percent of the minerals was dominated by muscovite and biotite micas of the gray layers.

2.1.5 VEGETATION

The Clark Fork Valley in the vicinity of Milltown is typical of lower elevation mountain valleys in western Montana. The valley slopes and surrounding mountains support forest stands of spruce, fir, and pine.

The lowland regions near the reservoir and river have poorly-drained, generally saturated soils characterized by mostly riparian and open grassland vegetation. Various forbs, sedges (Carex utriculata and Carex nebraskensis), spike-rushes (Eleocharis spp.), and grasses dominate these areas. Cattails (Typha sp.), bullrushes (Scirpus sp.), and willows (Salix spp.) are also common. The more elevated upland regions with coarser, well drained soils contain an understory of grasses (particularly redtop bentgrass (Agrostis alba), goldenrod (Solidago sp.), and other native forbs. Overstories in these areas consist of waterbirch (Betula fontinalis), mountain alder (Alnus incana), or willow. Forest communities further from the rivers are dominated by ponderosa pine (Pinus ponderosa), Douglas fir (Psudotsuga menziesii), and service berry (Amelanchier alnifola) (Curtis, 1985).

2.1.6 WILDLIFE AND AQUATIC ECOLOGY

The Blackfoot and Clark Fork Rivers contain rainbow, brown, cutthroat, and bull trout. Rainbow trout are more common near Milltown, while brown trout are more common upstream. Mountain whitefish and sucker species are also common. Within the Milltown Reservoir, rough fish such as northern squaw fish and suckers are prevalent. Game fish represent one percent of the population. Macroinvertebrate populations in the river bottom sediments appear healthy and diverse. Substantial numbers of mayflies, stoneflies, caddisflies, and Diptera larvae are present (CH2M Hill, 1983).

A trout standing crop electrofishing survey was completed in 1979 and 1980 along the Clark Fork by MDFWP personnel (Peters, 1981), to determine game fish populations. They found that trout populations were significantly

lower in the Clark Fork than in tributary streams; for example, trout populations in the Clark Fork below Rock Creek only amount to 35 percent of the populations found in Rock Creek. In addition, the study revealed a pattern of increased trout populations below the confluences of tributary streams with good water quality. For example, the Bonita section above Rock Creek averaged 9 trout per 1,000 feet of stream, while below Rock Creek 74 trout per 1,000 feet of stream were observed. As a comparison, the Blackfoot River supported 342 trout per 1,000 feet of stream at a location 11 miles upstream of Milltown.

However, trout populations at Milltown did not follow the pattern of increasing below the confluence with the Blackfoot River. Trout numbers were 16 percent less than those upstream from the dam at Turah. The study concluded that sediment flushing from the reservoir could be responsible, although other factors such as nutrient concentrations, dissolved oxygen, and channel characteristics may be involved (Peters, 1981).

Of the aquatic fauna resident in the Clark Fork River, trout and some benthic invertebrates are particularly sensitive to concentrations of arsenic, cadmium, zinc, and particularly copper in their environment. Canton (personal communication, 1985) reports that benthic organisms are apparently not as affected by metals transport as by dam drawdowns which release large amounts of sediment. Trout are susceptible to copper in the streams (Phillips, 1985); copper concentrations in gill tissue from brown trout from a fishkill in the vicinity of Warm Springs on August 1, 1984 ranged from 14 to 40 µg/g (indicative of lethal exposure levels). Other potential factors such as lack of oxygen or gill clogging from large sediment loads were not evaluated, although fish gill cadmium concentrations were found to be less than acute toxicity levels.

The Milltown Reservoir has created valuable riparian habitat for waterfowl and game supporting birds, mammals, reptiles and amphibians as indicated in the Montana Power Company FERC application (Curtis, 1985). Canada geese were reintroduced to the area in 1979 (Curtis, 1985). Bald eagles, the

only known endangered species, and golden eagles winter in the Milltown area. Big game such as white tailed deer and elk, and smaller mammals including beaver, muskrat, skunk, and marmot inhabit the area (CH2M Hill, 1983).

2.1.7 DEMOGRAPHY AND LAND USE

The Milltown site is located directly adjacent to the community of Milltown, Montana. The smaller community of Bonner borders Milltown on the northeast. Other nearby towns include West Riverside, Pinegrove, and East Missoula, all located within 3 miles west of the site. Several residents also live at Bonner Junction, on the south side of the reservoir and one mile upstream of Milltown Dam. The 1980 census included Bonner, Milltown, West Riverside, and Pinegrove into one population center. Total population was 1,742 and the median age was 26.8 years. East Missoula was listed as a separate population center with a total population of 1,707 and the same median age as the Milltown-Bonner center. Most residents in these communities are younger working people or young families. The town of Missoula itself, located 5 miles west of the site with a 1970 population of 29,497, is western Montana's main trade center. Employment in the services industries is high in Missoula.

Milltown and surrounding communities are primarily residential with some industrial, commercial, and agricultural uses also present. The largest industrial use in the area is the Champion International Plywood Mill at Bonner. This facility is located along the eastern bank of the Blackfoot River just upstream of its confluence with the Clark Fork at the Milltown Dam. The Milltown Dam also represents an industrial use in the area. It is operated as a hydroelectric facility by the Montana Power Company (MPC) and produces approximately 225 kW of electricity. MPC is currently (June, 1988) upgrading the facility in accordance with their Federal Energy Regulatory Commission (FERC) application (Curtis, 1985) to increase power output to 4,300 kW.

The Clark Fork River in the vicinity of the dam affords some recreational use, primarily by boaters, hunters, and fishermen (Curtis, 1985). Pasture areas in the upper regions of the reservoir itself are used for livestock grazing and may also be used for hay production. Lands of the Lolo National Forest are located south of the Milltown site.

2.1.8 MILLTOWN DAM

Prior to rehabilitation work begun in the fall of 1986, the Milltown Dam was composed of an overflow spillway, gated sluiceway, non-overflow rock-filled crib, rock-filled timber crib forebay, concrete gravity section, and powerhouse (Curtis, 1984). The height of the dam above the river bed was about 64 feet and the overall length was 668 feet, with a gross head on the dam of 30 feet. The sluiceway was controlled by four steel sluice gates (14 feet high by 9 feet wide) with an invert elevation of 3,232 feet (MPC datum, which is 1.45 feet below the USGS MSL datum). The spillway was controlled by manually operated bear trap type flashboards. When raised, the flashboards raised the reservoir to a normal operating level of 3,259.7 (MPC datum); when lowered, the spillway crest elevation was 3,252 (MPC datum).

The total storage capacity of the reservoir has been estimated to be 820 acre-feet with a total surface area of 500 acres at the normal operating level of 3,259.7. However, because of losses due to silting, the present capacity is probably less than 800 acre-feet (Engineering Management Inc., 1982). The powerhouse contains five turbine-generator units with a generating capacity of 3,000 KW.

Previous (pre-rehabilitation) operations of the dam called for drawing down the reservoir seven to eight feet to the dam crest to reset the spillway flashboards after the flow had dropped below 5,000 cfs. This drawdown was generally conducted every Spring and resulted in erosion of the river channel through the reservoir and elevated turbidity levels downstream (Curtis, 1985). Prior to 1981, the drawdowns were conducted over a shorter

interval in time than in the years since (the seven- to eight-foot drop normally occurred in one 14-hour period); operations since 1981 limited the rate of reservoir drawdown to one foot per day.

Due to the poor condition of the turbine generator units, spillway, and other components of the dam, MPC investigated various options for retiring and/or rehabilitating the Milltown Dam facilities. Based on an engineering evaluation of the hydroelectric project (Curtis, 1984), the recommended action was to rehabilitate the project while recognizing that this was not economically feasible, but less costly than retiring the project when replacement power cost was considered. An Application for Amendment of License was filed by MPC before the Federal Energy Regulatory Commission (FERC) in July 1985 (MPC, 1985) to permit the rehabilitation of the project. Prior to the FERC issuing an order on MPC's application, massive ice floes severely weakened the spillway in February 1986. The FERC invoked its authority to require the licensee to make emergency repairs to the spillway to protect life, health, and property. Consequently, MPC replaced the rock-filled spillway with a reinforced concrete spillway during the fall of 1986 and the winter of 1987 (FERC, 1988a). The spillway replacement work by MPC is often referred to as the Phase I construction effort. Additional rehabilitation work (Phase II construction) proposed in the application includes:

- Replacing the spillgate and dividing block sections of the dam;
- Modifying other water-retaining sections of the dam, exclusive of the spillway;
- Rehabilitating the powerhouse; and
- Replacing the five existing generating wells with four new, vertical tube units to increase generating capacity from 3,000 KW to 4,300 KW.

MPC will continue to operate the project as a run-of-the-river hydroelectric facility to maintain the reservoir elevation at about 3,259.7 feet (MPC datum). The maximum hydraulic capacity would be 2,000 cubic feet

per second (cfs). Site access would be by way of existing roadways. The existing transmission line would connect the project with local power grids in the area (FERC, 1988a).

The FERC issued an Order amending MPC's license on February 12, 1988 (FERC, 1988a). The Order approved MPC's application except for the expansion of generating capacity to 4,300 KW, which was denied based on a staff finding that the proposed expansion was not economically beneficial. The Order also specifies conditions under which the license was granted concerning:

- Period of construction
- Approval of drawings and specifications
- Permissible drawdown rates both during and after construction
- Coffer dam construction and removal
- Coffer dam settling pond and waste disposal area design and operation (see below)
- Monitoring of contaminants released from the settling pond and reservoir
- Various reports and plans required (arsenic risk assessment, waste transportation plan, monitoring plans, emergency response plan, etc.)

As previously mentioned, the Phase I construction was completed during the winter of 1987. The FERC-approved Phase II construction began in the summer of 1988. The FERC Order requires that construction be completed within two years from the issuance date of the Order -- February 12, 1988 (FERC, 1988a).

The Phase II construction includes installation of a cofferdam to dewater the area upstream of the powerhouse intake and the sluicegate to allow rehabilitation of these components. To reduce the sediment level of water pumped from the cofferdam, discharges are released into a 20 acre-foot settling pond, from which MPC monitors effluent discharges into the reservoir (FERC, 1988a).

Waste materials and construction debris originating from rehabilitation of the Milltown Dam facilities are transported and deposited in a separate upland waste disposal site as mandated by the FERC. Six disposal site alternatives were originally presented to the FERC. MPC officials, with concurrence of State and Federal agencies, chose the alternative requiring construction of a lined disposal facility on the abandoned railroad right-of-way located on the south shore of the reservoir, downstream of the mouth of Deer Creek. Transportation of the waste materials to the disposal site is conducted under MPC's transportation plan, approved in part and modified in part by the FERC per its Order of September 15, 1988 (FERC, 1988b).

The two acre disposal site is split into two cells by an earthen dike. After clearing, grubbing, and stripping of all organic material and unsuitable substances, the foundations and embankments were constructed of compacted 12 inch lifts of shell material (suitable resident organics and clays), clay, and sand bedding. After completion of the foundation and embankments one cell was lined with .08 inch PVC material (.04 inch material was permitted). A drainage system consisting of perforated PVC pipe has been installed on top of the liner. The pipe has been covered with 24 inches of gravel drain material to aid drainage and prevent damage to the pipe during placement of waste materials. The drain functions to transport effluent leaking from saturated waste materials into a lined storage sump for future sampling or treatment.

All waste material that has come into contact with metal bearing sediments was placed in the lined cell. More specifically, contaminated spoils from the forebay (5,160 yd^3), dam crib, and support structures (4,870 yd^3) have been isolated in the lined cell. The unlined cell will be used for disposal of uncontaminated materials such as the cofferdam embankment.

After all waste materials have been placed in the lined disposal area, a clay cap will be constructed over the site. The clay cap will be compacted

into a convex or mounded shape to allow future settlement of waste materials and to drain runoff away from the disposal area.

Following rehabilitation, MPC considers that annual drawdowns of the reservoir will no longer be necessary (Curtis, 1985). Sediment loading to the Clark Fork River below the dam will occur from natural flood events and infrequent drawdowns of six feet to reset tripped spillway stanchions (statistically once every 14 years). Maintenance drawdowns will be limited to ten feet and will occur infrequently due to modernization of the dam. Mitigation activities proposed by MPC for the future operation of the reservoir include:

- Limiting the drawdown rate to a maximum of one foot per day when reservoir elevations are between 3,260 feet and 3,256 feet MSL, and to a rate of 0.5 feet per day when reservoir elevations are less than 3,256 feet MSL (drawdown rates may be temporarily modified during emergencies or upon mutual agreement with MDHES).

- Measurement of instream turbidity after each change in floodgate position; appropriate adjustments of floodgates will be made if turbidity levels are excessive.

- Use of the turbine generators as long as possible in the drawdown operation with a gradual switch over to passing water through the floodgates.

- Controlling the spill during spring runoff by the left side (looking in the downstream direction) flashboards to maintain the sediment carrying capability of water as it passes through the reservoir.

2.1.9 COMMUNITY CONCERNS

Following discovery in 1981 that four of Milltown's wells were contaminated with arsenic and other heavy metals, the local community was advised not to drink or cook with water from those wells. Much of the town then began hauling in drinking water (MontPIRG, 1983). As a result, community concerns in Milltown are primarily related to the health effects of contaminated drinking water. An educational campaign addressing potential health effects of water contamination in Milltown was sponsored by a local citizen group (Missoula People Action) in September 1982. A health study

conducted in 1983 found skin and respiratory problems to be the primary health considerations in the Milltown community (MontPIRG, 1983). Since installation of a new water supply system, residents in Milltown consider the arsenic contamination problem resolved. Members of the Milltown Water Users Association have expressed an interest in permanent solutions to the problems of ground water contamination in their community. Also, prospective new residents have expressed concern about possible ground water problems (Corti, 1985). Contaminated surface water reservoir sediments have caused local concern. The biggest concern expressed is the fear of the dam failing and releasing sediments downstream. Other concerns voiced by Milltown area residents and officials are the possible health effects sediments may have on people and wildlife who use the reservoir.

A new community water system for Milltown was completed during 1985. No metal contamination has been found in other community water supply systems or in private wells and no plans are presently in order to develop new systems. An ongoing program of community relations is conducted by MDHES.

The Clark Fork Coalition, a nonprofit citizens group, is also concerned about the release of contaminants from the Milltown Reservoir to downstream waters and river sediments. In particular, the Clark Fork Coalition believes that a release of contaminated sediments could adversely impact downstream aquatic life and pollute drinking water supplies. The Clark Fork Coalition formally notified EPA in August 1988 that a release of contaminants had occurred from the Milltown site into downstream waters as the result of the June and July 1988 drawdown of the reservoir by Montana Power Company. It is expected that the Clark Fork Coalition will remain involved in issues at the Milltown site.

A group of residents at Bonner Junction, located adjacent to the south side of the reservoir and one mile upstream of Milltown Dam, expressed concern about the site during the summer of 1988. The Bonner Junction residents are concerned about potential contamination of their ground water supplies from the reservoir sediments and exposure to heavy metals from direct

contact with the sediments and dust. The residents are also concerned with the MPC Milltown Dam Rehabilitation sediments disposal pond, which is located adjacent to their property. The Bonner Junction residents will probably remain active in issues that directly affect them at the Milltown site.

2.2 CONTAMINATION PROBLEM DEFINITION

Identified problems at the Milltown site include heavy metal contamination of local ground water, heavy metal contamination of surface water exiting the reservoir, and resuspension and release of sediments from the reservoir. These problems result in impacts to the local human population and the environment. Impacts are:

- o Contamination of domestic water supply wells in Milltown,
- o Contamination of reservoir soil/sediment and wildlife habitat,
- o Possible contamination of ground water supply wells downgradient of the reservoir in adjacent communities,
- o Possible discharge of potentially contaminated ground water to surface waters downgradient of the reservoir,
- o Degradation of downgradient surface water quality resulting from release of contaminated water or resuspended sediments from the reservoir,
- o Possible plant, animal, or human uptake of heavy metals and movement of these contaminants through the food chain, and
- o Reduction in aquatic habitat quality or habitat productivity in the Clark Fork River and in Milltown Reservoir resulting from contact with the sediments and contaminated surface water, and/or from turbidity increases associated with high flow or reservoir drawdown conditions.

Problems associated with contaminant releases downstream and downgradient of the Milltown Reservoir sediments may be defined as a result of an ongoing screening study being conducted by CDM in 1988. That study will determine if contaminant releases from the reservoir have resulted in

potential problems at downstream locations. Surface waters, ground water, sediments, and irrigated soils will be evaluated between Milltown Dam and the confluence of the Clark Fork and Bitterroot Rivers. Additional RI/FS work on Milltown Reservoir contamination may be required if the screening study so indicates.

2.2.1 DEGREE OF METAL CONTAMINATION

Metals contamination has been identified in surface waters, primarily connected with suspended sediments, ground water, reservoir sediments, soils, and vegetation at the Milltown Reservoir Sediment site. Evidence for contamination and the extent, areally and quantitatively, of contamination is discussed below.

Surface Water

The water quality of the Clark Fork River has been impacted by metals from mining activities upstream of Milltown. Concentrations of dissolved constituents in the water are fairly low. Mining wastes have been transported by suspended sediments in the river. The Clark Fork upstream of Milltown is estimated to transport approximately 120,000 tons of suspended sediment per year (CDM, 1986). Table 2-1 presents some selected values for dissolved and total metals in water samples showing their relative concentrations. From this limited data, it appears that totals concentrations of copper, arsenic, and possibly zinc increase from upstream to downstream of Milltown Reservoir as do total suspended solids. Mean metals concentrations of copper shown in Table 2-1 exceed Ambient Water Quality Criteria (AWQCs). Concentrations remain below SDWA criteria. Results for copper from samples of river bed sediments, taken and analyzed for the National Uranium Resource Evaluation (NURE) program (Aamodt, 1978), are also presented in Table 2-1 for upstream reaches.

In Milltown Reservoir, contaminated suspended sediments settle out, usually with organic material and are buried by subsequent deposits. Sediments

TABLE 2-1

SELECTED SURFACE WATER QUALITY MEASUREMENTS - MILLTOWN VICINITY

	Date	Flow Rate (cfs)	Dissolved Arsenic (µg/L) No. of Samples	Dissolved Arsenic (µg/L) Mean	Total Arsenic (µg/L) No. of Samples	Total Arsenic (µg/L) Mean	Dissolved Lead (µg/L) No. of Samples	Dissolved Lead (µg/L) Mean	Total Lead (µg/L) No. of Samples	Total Lead (µg/L) Mean	Dissolved Zinc (µg/L) No. of Samples	Dissolved Zinc (µg/L) Mean
Clark Fork Below Milltown (at Missoula City Limits)	7/10/69 to 4/7/71	3600[1]	18	3.06	-	-	24	0.33	5	19.6	25	20.0
Clark Fork Below Milltown (within City of Missoula)	4/24/80 to 7/9/80	-	5	7.40	6	20.49	1	(2)	1	(2)	5	28.60
Clark Fork Above Milltown (at Turah)	2/22/79 to 7/19/82	2350[1]	7	8.14	20	8.80	4	(2)	11 2	(2) 130	6 3	23.49 (2)
Blackfoot River above Milltown (Wisherd Bridge)	4/24/80 to 11/1/83	-	5 3	1.40 (2)	15 7	1.07 (2)	4	(2)	1 9	50 (2)	3 5	23.32 (2)
Stream Sediment Clark Fork Average for Reach 4 miles above Milltown	5/14/77	NA	-	-	-	-	-	-	-	-	-	-
Stream Sediment Blackfoot Average for Reach 4 miles above Milltown	5/8/77	NA	-	-	-	-	-	-	-	-	-	-
SDWA[3]		NA	-	-	-	50[a]	-	-	-	50[a]	-	-
Ambient Water Quality Criteria (AWQC)												
Aquatic Life WQC[4]		NA	-	-	-	360[c] 190[d]	-	-	-	142[c] 5.6[d]	-	-

TABLE 2-1 (Cont.)

SELECTED SURFACE WATER QUALITY MEASUREMENTS - MILLTOWN VICINITY

	Total Zinc (µg/L)		Dissolved Cadmium (µg/L)		Total Cadmium (µg/L)		Dissolved Copper (µg/L)		Total Copper (µg/L)		TSS (mg/L)	
	No. of Samples	Mean	No. of Samples	Mean	No. of Samples	Mean	No. of Samples	Mean	No. of Samples	Mean	No. of Samples	Mean
Clark Fork Below Milltown (at Missoula City Limits)	5	162.0	18	0.011	-	-	24	10.63	5	94.0	-	-
Clark Fork Below Milltown (within City of Missoula)	6	33.28	5	(2)	5 1	(2) >6.	3 2	13.32 (2)	6	163.29	7	243.1
Clark Fork Above Milltown (at Turah)	28	55.56	7	(2)	13 3	(2) >5.7	5 4	16.00 (2)	28	19.60	8	35.87
Blackfoot River above Milltown (Wisherd Bridge)	7 17	65 (2)	7	(2)	11 1	(2) >6	4 4	10.0 (2)	4 20	17.5 (2)	5	10.04
Stream Sediment Clark Fork Average for Reach 4 miles above Milltown	-	-	-	-	-	-	-	-	7	200 ppm	-	-
Stream Sediment Blackfoot Average for Reach 4 miles above Milltown	-	-	-	-	-	-	-	-	7	32 ppm	-	-
SDWA(3)	-	5000[b]	-	-	-	10[a]	-	-	-	1000[b]	-	-
Ambient Water Quality Criteria (AWQC) Aquatic Life WQC(4)	-	170[c] 154[d]	-	-	-	6.4[c] 1.6[d]	-	-	-	27[c] 17[d]	-	-

References: Taken from EPA (1985b) and Aamodt (1978).

(1) mean value
(2) below detection limits
(3) Safe Drinking Water Act; 40 CFR Part 141, Subpart B
(4) Clean Water Act; 40 CFR Part 131
"-" not measured

[a] Primary MCLs (µg/L); total recoverable
[b] Secondary MCLs (µg/L); total recoverable
[c] 1-hr acute; hardness = 155 mg/L; total recoverable (µg/L)
[d] 4-day chronic; hardness = 155 mg/L; total recoverable (µg/L)

deposited in the reservoir tend to be resuspended during high flows by river scouring or during drawdowns of the dam for maintenance. Woessner et al. (1984) report the results of a drawdown performed on July 7, 1980. Prior to the drawdown, suspended sediment was moving into the reservoir from the Clark Fork and Blackfoot rivers at a rate of 4,065 grams per second. Sediment output below the dam was 5,113 grams per second, indicating re-suspension of sediment at the moderate flow rate of 5,920 cubic feet per second. After the dam flashboards were removed, decreasing the crest elevation by approximately 4 feet (Curtis, 1985), the sediment load below the dam increased to 142,914 grams per second. Although these results may be of limited value in accurately defining the physical mechanisms of sediment re-suspension processes, they do provide an indication of the system's operation.

Activities upstream of Milltown Reservoir have attempted to reduce sediment loading to the Clark Fork River. In 1911, the Anaconda Minerals Company (AMC) constructed a 20-foot-high tailings dam in an attempt to control sediment loading from Silver Bow Creek (Hydrometrics, 1983). This dam resulted in the creation of a tailings pond, near the confluence of Silver Bow Creek and the Clark Fork River, which is known as Pond 1. An additional dam was constructed by AMC upstream of Pond 1 in 1916. This dam formed Pond 2 and in 1967-1969 its height was raised from 18 feet to 23 feet (Hydrometrics, 1983). Pond 3 was created by construction of a 28-foot-high dam which was completed between 1954 and 1959. The height of this dam was increased to 33 feet during 1967-1969 (Hydrometrics, 1983). In 1967 AMC initiated treatment of Pond 3 effluent by adding a lime/water suspension to Silver Bow Creek above Pond 3 to facilitate precipitation of dissolved heavy metals in the Warm Springs Ponds. An estimated 20 million cubic yards of tailings and sludges have accumulated in the Warm Springs Ponds since 1911 (CH2M Hill, 1988). Mine tailings and smelting wastes were carried downstream from the Butte and Anaconda areas into the Clark Fork River from the initiation of mining activities in Butte during the 1880's until 1911 when Pond 1 was constructed. Since 1911 sediments have migrated down the Clark Fork during periods of high flow when the pond system was

bypassed or overtopped, after Pond 1 had filled with sediment and prior to construction of Pond 2, and when the pond system was not adequately operated such as during labor strikes. Hence, a significant volume of contaminated sediment may be present within the floodplain of the Clark Fork River between the Warm Springs Ponds and Milltown Dam.

Other activities upstream of Milltown Dam may lead to improvements of the Clark Fork River. The Warm Springs Ponds are the subject of a Phase II RI/FS which is currently being conducted by MDHES. Characterization of current treatment activities, pond bottom sediment composition and chemistry, ground water contamination below Pond 1, and metallic contamination in the Mill-Willow bypass sediments are among the objectives of this Phase II RI/FS. Bench scale treatability tests are also being conducted to evaluate alternative means of optimizing the current treatment process. Other problems which are being addressed include stability of the pond berms during floods and seismic events, seepage of contaminated ground water from the ponds to the Mill-Willow bypass and the Clark Fork River, transport of tailings from upstream reaches of Silver Bow Creek and the Mill-Willow Bypass to the Clark Fork River, and human/biota exposures to contamination at the Warm Springs Ponds. This RI/FS is scheduled for completion during early 1989.

Downstream, in the Hellgate Canyon reach of the Clark Fork, the valley narrows and contains less alluvium. The Clark Fork at this point is likely a "gaining" reach, that is water discharges from alluvium into the river. Surface waters in the area of Hellgate Canyon could potentially become contaminated if the ground waters in this section were also contaminated.

Sediments and Pore Water

Sediments contaminated with heavy metals that originate from the Butte/Anaconda mining and milling areas have been transported via fluvial transport processes. Sediments have accumulated in floodplain areas along the mainstem of the Clark Fork River (Moore, 1985b; Rice and Ray, 1985) and

behind Milltown Dam. The areal and vertical extent of contaminated sediments and variability of sediment composition at the Milltown Reservoir Site have been estimated through grab and core sediment sampling done as part of the RI (Woessner et al., 1984), the draft FS (HLA, 1986), and by Curtis (1985). Metals distribution with depth in the Milltown Reservoir sediments was highly variable between core locations for all metals of concern. This spatial variation may be related to historic shifts of the Clark Fork River channel and subsequent changes in scour and deposition conditions.

In the RI, total metals contents of the grab sample sediments were determined by fusion/dissolution with analysis by atomic absorption spectroscopy techniques. The results show variation in metal content based on sample location. The swampy or slough areas away from the main channel contain the highest concentrations of metals. The Clark Fork arm of the reservoir contains from 5 to 17 times the concentration of metals present in the Blackfoot arm. Iron concentrations were similar in both areas.

Woessner et al. (1984) also analyzed pore water from the grab samples, for which the data were more variable. The distinctions between the Clark Fork and Blackfoot arms of the reservoir were not as conclusive as with the total metals results. Table 2-2 summarizes the sediment quality in grab samples for total metals. Table 2-3 summarizes the data for sediment pore waters. Mean total metals concentrations in grab samples collected by MPC (Curtis, 1985) and HLA (1986) are also shown in Table 2-2. Grab samples in the latter reports are from the Clark Fork arm of Milltown Reservoir only. Summary statistics of the data are provided in Appendix C.

Total concentrations of all metals in surficial sediments are highest in the northern (Sites 21, 22, 34, Figure C-1) and southern (Sites 15, 30 Figure C-1) slough areas of the Clark Fork arm (Woessner et al., 1984). This distribution of grab sample sediment quality is substantiated by HLA (1986) as seen in Figures C-2 through C-8.

TABLE 2-2

SEDIMENT QUALITY IN GRAB SAMPLES
MILLTOWN RESERVOIR SEDIMENT[a]

	Woessner et al. (1984)[b]						
	BF Grab	CF Grab	CF Grab Upstream[c]		HLA (1986)[d]	MPC (1985)[e]	Phytotoxic Level[e,f]
n	11	23	5	(1)	24	5	
As	7.7	58	43	(12)	207	—	3-28
Mn	281	1,290	763	(600)	2,926	921	1,740
Fe	21,163	22,855	19,530	(16,700)	14,400	—	—
Cu	40	449	316	(192)	1,310	604	1,920
Zn	128	1,767	875	(752)	1,900	2,361	200-300
Pb	18	68	54	(37)	171	60	550-2,000
Cd	0.68	6.2	3.8	(2.6)	7	11	100
Ba	—	—	—	—	201	—	—
Cr	—	—	—	—	36	—	—
Data Source Pages	126	126	444	(444)	19	E-75	E-81

BF = Blackfoot CF = Clark Fork n = No. of samples "—" = Not Analyzed

[a] All metals concentrations are mean totals (µg/g).
[b] Woessner et al., 1984, Arsenic Source and Water Supply Remedial Action Study.
[c] Upstream on CF from reservoir sediments, Grab Sample Nos. 26, 27, 28, 24, 31.
[d] HLA, 1986, Draft Milltown Reservoir Feasibility Study.
[e] Curtis, 1985, FERC Application for Amendment of License.
[f] Totals levels in the soil at which adverse effects to plants may occur.

TABLE 2-3

PORE WATER QUALITY[a]

	Grab Samples			Core Sample	
	Pore Water BF	Pore Water CF	Pore Water Up-Stream[b]	Pore Water BF	Pore Water CF
n	11	23	5	6	64
As	.006	.05	.016	.005	1.18
Mn	1.8	6.9	3.64	.000	17.0
Fe	.39	1.9	1.19	.16	58.8
Cu	.009	.009	.002	.000	1.47
Zn	.05	.19	.01	.000	7.96
Pb	.006	.002	.000	--	--
Cd	.001	.002	.001	--	--
Ni	.06	.02	--	--	--
Data Source Pages[c]	134	134	443	155-157	155-157

BF = Blackfoot CF = Clark Fork n = No. of samples "__" = Not Analyzed

[a] All metal concentrations are mean values (mg/l).
[b] Upstream on CF from reservoir sediments, Grab Sample Nos. 26, 27, 28, 24, 31.
[c] Woessner et al., 1984, Arsenic Source and Water Supply Remedial Action Study.

In the RI, sediment cores, drilled to a maximum of 5 feet, were analyzed for total metals, acetic acid extractable metals, EP tox metals, and pore water, as a function of depth. Core 1 (See Figure C-1) taken from the Blackfoot arm of the reservoir showed no variation of metal content with depth. The cores from the Clark Fork arm showed significant trends with depth. Total arsenic, manganese, copper, zinc, lead, and cadmium all increased in concentration with depth. For example, in Core 3, taken from the northern swampy portion of the Clark Fork arm of the reservoir adjacent to Interstate 90, copper increased from 1,500 ppm at the surface to 10,800 ppm at a depth of 30 inches. Arsenic also increased dramatically in Core 3, from about 75 ppm at the surface to 1,500 ppm at 5 feet. Tables 2-3 and 2-4 summarize the RI data for pore waters and core sediments, respectively. Appendix C also provides tabulated summary statistics from Woessner et al. (1984) for arsenic analyses.

Mean concentration of total metals in sediment cores reaching depths of 25 feet are generally lower than those in the upper 5 feet of sediment (Table 2-4). Areal and vertical distribution of total metals in reservoir sediments down to 25 feet of depth can be seen in Figures C-2 to C-8 taken from the Feasibility Study (HLA, 1986).

Arsenic, copper, zinc and lead concentrations in shallow soils (less than 2 feet deep) showed depletion of metals possibly the result of plant uptake and/or leaching by recharge waters. Maximum concentrations occurred at depths between 5 and 20 feet for these metals and, spatially, in cores nearest Milltown. Zinc concentrations, an exception, were also high in the first two feet of sediments in the southern slough area (MR-8 and MR-12).

Manganese concentrations, on the other hand, were greatest in the top 10 feet of sediment. Iron and barium were fairly evenly distributed with depth. Iron levels mimicked behavior of other metals. Cadmium concentrations were consistently low. The M-11 core nearest Milltown shows a consistent pattern of metal concentration with depth for all metals

TABLE 2-4

MEAN SEDIMENT QUALITY OF CORE SAMPLES
MILLTOWN RESERVOIR SEDIMENT[a]

	Woessner (1984)[b]						
	BF Core	CF Core	MPC (1985)[c]	HLA (1986)[d]	Mean EP TOX (mg/L)[c]	Maximum EP TOX (mg/L)[c]	EP TOX REGS (mg/L)[e]
n	6	64	17	81	17		
As	6.4	320	18	199	0.024	0.07	5.0
Mn	255	1,648	702	922	54.6	844	—
Fe	19,467	—	16,160	14,400	0.07	0.34	—
Cu	37	2,182	1,140	1,296	0.14	0.90	—
Zn	52	4,045	1,248	1,923	3.3	10.7	—
Pb	19	262	109	166	0	0	5.0
Cd	0.98	15.2	16	—	0.018	0.07	1.0
Ba	—	—	162	203	0.35	0.80	100
Cr	—	—	27	—	0.07	0.31	5.0
Data Source Pages	143-146	175,146	App. D	Figures 3-9	App. D	App. D	

(-) Data not available.

[a] All values are total metals in mg/kg unless noted otherwise.
[b] Woessner et al., 1984, Arsenic Source and Water Supply Remedial Action Study - mean includes samples from core depths to 5 feet.
[c] Curtis, 1985, FERC Application for Amendment of License - mean includes samples from discrete core depths at 3 to 4.5 (n=5), 8 to 9.5 (n=5), 13 to 14.5 (n=4) and 18 to 19.5 (n=3) feet.
[d] HLA, 1986, Draft Milltown Reservoir Feasibility Study - mean includes samples from core depths to 25 feet.
[e] Source: 40 CFR 261.24 (—) No EP TOX regulation values assigned.

except manganese and zinc. For example, arsenic at M-11 increases at the 5 foot level, decreases below this and gradually increases to the peak value at 20 feet.

The metals concentrations revealed by analysis of the reservoir sediments were converted by Woessner et al. (1984) and CDM to absolute amounts of metals in the reservoir sediment. This was to determine the amount of metals potentially available to the environment at Milltown. The total quantity of reservoir sediments has been estimated to be 120,000,000 cubic feet (3.4 million cubic meters). Using a typical sediment density of 1.8 grams/cc, then 6.1×10^{12} grams of sediment are present. Using the mean value and subtracting assumed appropriate background levels of metals (Woessner et al., 1984, p. 179-181), the following metals quantities were calculated to be contained in the sediment:

Arsenic	-	1,800 tons
Manganese	-	11,000 tons
Copper	-	15,000 tons
Zinc	-	27,000 tons
Lead	-	1,800 tons

Ground Water

Water samples from monitoring well networks installed by Woessner et al. (1984) and HLA (1986) and from private wells were analyzed to determine the water quality of the alluvial aquifer. Locations of samples and maps of observed contaminant concentrations are shown in Woessner et al. (1984) and HLA (1986). In general, the water is a calcium-bicarbonate type. Samples from wells completed in the upper weathered and fractured bedrock show a sodium-bicarbonate chemistry type. Mean concentrations of metal contaminants in portions of the ground water system are given in Table 2-5.

The highest values of TDS, iron, arsenic, and manganese are found in the reservoir sediments directly north of the reservoir, extending to about 1,300 feet north of Interstate 90. Low TDS and metals values were observed north of Milltown, adjacent to the Champion plant. This area is recharged

TABLE 2-5

CONCENTRATIONS OF HEAVY METALS IN SEDIMENT PORE WATER AND GROUND WATERS AT, AND ADJACENT TO, MILLTOWN RESERVOIR

Sampling Locations	Arsenic		Copper		Zinc		Iron		Manganese		Barium		Chromium	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
A. Heavy Metal Concentrations Identified During the Remedial Investigation (Woessner et al., 1984)														
Sediment pore waters	0.005–7.90	1.11	0.00–23.0	1.39	0.00–83.0	7.49	0.009–592	55.4	0.00–117	16.9	NA	–	NA	–
Reservoir sediment wells	0.01–10	3.48	0.00–0.036	0.0073	0.00–0.900	0.271	7.8–64.0	39.6	1.97–13.0	6.33	NA	–	NA	–
Off-site (I-90) wells	0.00–1.1	0.339	0.00–0.00	0.00	0.00–0.800	0.300	0.00–41.9	7.55	0.00–11.0	4.63	NA	–	NA	–
Southwest Milltown wells	0.0002–0.825	0.316	0.00–0.050	0.030	0.00–0.962	0.128	0.00–24.0	3.28	0.008–14.0	5.2	NA	–	NA	–
Northeast Milltown wells	0.00–0.093	0.0057	0.00–0.050	0.016	0.00–0.934	0.075	0.00–8.40	0.391	0.00–4.40	0.57	NA	–	NA	–
Wells west of Blackfoot River	0.00–0.025	0.0018	0.01–0.012	0.011	0.00–0.282	0.047	0.00–0.372	0.054	0.00–0.580	0.14	NA	–	NA	–
B. Feasibility Study (HLA, 1986)														
Reservoir sediment wells	0.068–5.0	1.16	0.00–0.005	–	0.023–0.65	0.10	0.1–55	26.01	3.7–12	7.94	0.17–0.56	0.34	ND*	–
Off-site (I-90) wells	0.52–1.4	0.99	ND	–	0.006–0.53	0.15	7.6–20	14.1	5.4–11	8.1	0.23–0.97	0.63	0.0–0.007	–
Southwest Milltown wells	0.002–0.032	0.019	ND	–	0.009–0.054	0.025	0.0–5.1	1.61	0.008–4.7	1.73	0.043–0.48	0.23	0.0–0.011	0.009
Northeast Milltown wells	0.0–0.039	0.015	0.0–0.006	–	0.006–0.043	0.034	0.0–4.9	–	0.007–2.8	0.57	0.15–0.95	0.28	0.0–0.006	–
Wells west of Blackfoot River	0.0–0.082	0.065	0.0–0.046	0.025	0.005–0.097	0.035	0.0–0.25	0.12	0.012–3.9	1.49	0.049–0.36	0.21	ND	–
Upgradient Blackfoot River wells	ND	–	ND	–	0.16	–	ND	–	ND	–	0.19	–	ND	–
Upgradient Clark Fork wells	0.007–0.015	0.011	0.0–0.005	–	0.004–0.014	0.0077	ND	–	0.0–1.2	0.61	0.098–0.13	0.12	0.0–0.011	0.01
Downgradient wells	0.0–0.005	0.004	0.0–0.004	0.004	0.006–0.56	0.28	ND	–	0.0–0.019	0.015	0.15–0.28	0.18	ND	–
SDWA[a] Standards	–	50[a]	–	1000[b]	–	5000[b]	–	300[b]	–	50[b]	–	1000[a]	–	50[a]

Note: Means were calculated for detected values only. Barium and chromium were not analyzed in the Remedial Investigation. Sediment pore waters were not analyzed during the Feasibility Study. All values are in mg/l total metals unless noted otherwise.

* ND = Not detected.

SDWA = Safe Drinking Water Act; 40 CFR Part 141, Subpart B.

[a] Primary MCLS (µg/l); total recoverable.

[b] Secondary MCLS (µg/l); total recoverable.

by the Blackfoot River. The aquifer east and northeast of the site, which is recharged by upstream ground water flow of the Clark Fork River, was uncontaminated. Based on Woessner, et al., 1984 and additional evaluation, EPA has concluded that the northward flow of contaminated ground water originating from the reservoir sediments has caused contamination of a portion of the alluvial aquifer.

Based on a permeability of 10^{-5} cm/sec (0.028 ft/day) for the fine-grained reservoir sediments, a gradient of 0.002, and an area of the reservoir sediments of 186 acres, a flux of about 250,000 ft^3/day flows downward from the reservoir sediments into the alluvial aquifer. Based on estimates of metals present in the pore water, the flux through the sediments carries the following amounts of metals: arsenic, 18 lbs/day; manganese, 260 lbs/day; copper, 23 lbs/day; zinc, 124 lbs/day; and iron, 920 lbs/day. The above figures were calculated using data reported in Woessner et al. (1984).

The areal and vertical extent of ground water contamination upgradient of Milltown Dam was characterized by Woessner et al. (1984). Additional data collected during the supplemental field investigations by HLA (1986) indicated that the contaminant plume extends downgradient below the dam to the area northwest of the Blackfoot River and east of the intersection of Highway 10 and I-90. However, the HLA (1986) investigation did not determine the full downgradient extent of contamination. Limited sampling of wells was conducted due to low reservoir stage, resulting in many dry wells downgradient. Water level measurements by HLA (1986) also indicate a potential for upwelling of contaminated ground water to the lower Clark Fork River.

Vegetation

Plant uptake of heavy metals is subject to variables that may include inter-specific and sub-specific genetic variation, climate, phenology, and physical characteristics of the site (soils) as well as plant availability

of the metals. Based on work by Rennick and coworkers (1984) and summarized by MPC (1985) various plant species growing on flooded or seasonally-saturated sediments may contain slightly elevated levels of arsenic, cadmium, and copper at the Milltown site. Arsenic in the plant leaves in Rennick's study range from a low of 0.75 µg/g in Carex rostrata (sedge) to a high of 1.54 µg/g in Phalaris arundinacea (canary grass). The Agrostis alba, a bentgrass, sample had 0.92 µg/g arsenic. A range of 0.1 to 0.7 µg/g arsenic represents arsenic concentrations of grasses from uncontaminated areas according to a literature survey completed by Rice and Ray (1984). Cattail leaves in Milltown Reservoir contained 0.91 µg/g arsenic. Cattails from remote lakes in the Michigan upper peninsula contained 0.05 µg/g arsenic in the leaves. On Charity Island in Lake Huron, which is a slightly contaminated site, cattail leaves contained 0.34 µg/g arsenic in leaves and 0.45 µg/g arsenic in roots (MPC, 1985). Arsenic concentrations in the other emergent species in Milltown Reservoir were 1.18 µg/g for Eleocharis palustris (spike-rush) and 0.83 µg/g for Glyceria grandis (mannagrass).

Cadmium concentrations in redtop bentgrass from Milltown Reservoir were 0.49 µg/g. Rice and Ray (1984) suggest that grasses from uncontaminated areas may contain 0.05 µg/g cadmium. The other species had cadmium concentrations less than 0.25 µg/g, except for water birch at 1.69 µg/g cadmium, and may not represent elevated levels.

Copper levels in Milltown vegetation were more variable, ranging from 2.69 µg/g to 19.8 µg/g. Spike-rush contained 19.8 µg/g copper, Carex rostrata (sedge) 13.6 µg/g, Solidago gigantea (goldenrod) 16.8 µg/g, Salix (willow) 12.0 µg/g, and Alnus incana (alder) 11.6 µg/g. Redtop bentgrass contained 2.88 µg/g copper which is below the median reported for uncontaminated areas (Rice and Ray, 1984). Cattails at Milltown contained 4.73 µg/g copper which is a typical value for cattails from uncontaminated sites (MPC, 1985). However, Typha spp. appear to have a specific mechanism for excluding excess copper from aboveground plant parts even on highly copper-contaminated soils (MPC, 1985).

The above indicates elevated levels of metals in the leaves of certain species found at Milltown Reservoir. Comparison of these levels with Critical Plant levels and Maximum Tolerable Dietary levels for foraging animals is shown in Table 2-6. Toxicity levels in sediments for total metals, shown in Table 2-2, indicate that the sediments contain potentially toxic levels of arsenic, manganese, and zinc. Due to lower concentration of metals in the root zones or lack of availability to plants, leaf concentrations of plants are below Critical Plant levels for arsenic, cadmium, copper, and lead. Concentrations that exceeded the Maximum Tolerable Dietary level were generally in plants not used as forage.

2.2.2 POTENTIAL CONTAMINANT PATHWAYS AND RECEPTORS

At the Milltown site, the environmental media of concern include surface water, ground water, sediment, and air. Potential contaminant pathways and receptors may be summarized as follows:

	Media	Pathway	Receptor
1.	ground water	ingestion/contact	humans, wildlife
		ingestion/contact	aquatic life*
2.	surface water	incidental ingestion/contact	humans, wildlife
		ingestion/contact	aquatic life*
3.	sediment	incidental ingestion/contact	humans, wildlife
		inhalation	humans, wildlife
		ingestion/contact	aquatic life
4.	air	inhalation	humans, wildlife

* The effect of ground water on aquatic life depends upon the degree to which ground water discharges to the surface water system.

Table 2-7 summarizes metal concentrations observed in water. Also included are regulatory levels for drinking water protection.

TABLE 2-6

RANGE IN ACTUAL CONCENTRATIONS AND SUGGESTED CRITICAL PLANT AND MAXIMUM TOLERABLE DIETARY LEVELS FOR As, Cd, Cu, Mn, Pb, and Zn FOR VEGETATION SAMPLES COLLECTED FROM MILLTOWN RESERVOIR[a]

Element	Milltown Range (ppm)	Critical Plant Level[b] (ppm)	Maximum Tolerable Dietary Level[c] (ppm)
As	0.56 - 2.38	70	50
Cd	0.02 - 4.71	5-70	0.5
Cu	1.86 - 19.8	20-40	25-800
Mn	25.2 - 1590	250-2500	1,000
Pb	0.22 - 7.99	10-193	30
Zn	32.8 - 988	300-500	300-1,000

[a] Adapted from MPC, 1985 (Table 3.1-14).
[b] The level in the plant, at which adverse affects to growth and development of the plant may occur.
[c] The dietary level that, when fed for a limited period, will not impair animal performance and should not produce unsafe residues in human food derived from the animal.

TABLE 2-7

CONTAMINANTS OF PRIMARY CONCERN AT THE MILLTOWN, MONTANA SITE
AND POSSIBLE ARAR-DEFINED LEVELS
(All Concentrations in ug/liter)

Element	Total Stream Loadings[1]			Maximum Ground Water Concentrations in Former Water Supply Wells from 1981-1984	Possible ARAR-Defined Levels			
	Clark Fork		Blackfoot			Aquatic Life WQC[5]		Gold Book Human Health[6]
	Downstream	Upstream	Upstream		MCL[2]	Acute[3]	Chronic[4]	
Arsenic	8.3	8.4	1.0	825	50[a]	360	190	0.0022
Cadmium	9.5	10.2	9.8	ND	10[a]	6.4	1.6	10
Copper	63.6	25.3	11.0	50	1,000[b]	27	17	1,000[7]
Iron	—	—	—	24,000	300[b]	1,000	1,000	300
Lead	49.7	54.8	>50	ND	50[a]	142	5.6	50
Manganese	—	—	—	14,000	50[b]	—	—	50
Zinc	187.7	55.8	22.8	806	5,000[b]	170	154	5,000[7]
Total Suspended Solids	209,500	26,600	10,000	—	—	—	—	—

1 Information from CDM (1986) Tables 5.1 and 5.2 with:
- — Table based on USGS and STORET data (USEPA, 1985).
- — Numbers representative of averages of samples taken on various dates between 4/68 and 11/83.
- — Numbers as averages of seven different sampling stations.

2 Safe Drinking Water Act; 40 CFR Part 141, Subpart B.
- a Primary MCLs
- b Secondary MCLs

ND = Not detected

3 1-hour acute; hardness = 155 mg/L

4 4-day chronic; hardness = 155 mg/L

5 Clean Water Act; 40 CFR Part 131.

6 USEPA - Gold Book (1986)

7 Estimated

Residential ground water wells in Milltown have been contaminated with heavy metals. The contamination is due to recharge of ground water by the Milltown reservoir. This exposure pathway, mobilization of metals from reservoir sediments under reducing conditions and movement of ground water, has been well documented by Woessner et al. (1984). Domestic use of ground water completes the pathway to humans. Discharge of ground water downstream of Milltown may affect surface water quality and aquatic life.

Possible exposure mechanisms in surface water for aquatic life and humans within and downstream of the reservoir include:

- o High suspended solids during high flow or dam drawdown conditions,
- o High concentrations of metals connected with sediments during high flow or drawdown conditions,
- o Discharge of contaminated ground water to surface flows downstream of the dam,
- o Depletion of oxygen due to metals or organics is not considered a possible mechanism in streams because of the following reasons: Organics make up only a small fraction of the sediments (about 2%, based on data in the report by Woessner et al., 1984); with the exception of iron, the concentrations of metals in the sediments and the consequent rates of reduction are low; and because of the high recreation rate from stream turbulence. In areas not mixed by flow-through conditions, sediment oxygen depletion may be a possible mechanism.
- o Settling of suspended loads after release from the reservoir in downstream sections of the Clark Fork.

Aside from the mechanisms outlined above related to sediment resuspension in surface waters, other mechanisms of exposure to sediment involve direct contact or ingestion of sediment within, around, or downstream of the reservoir. Air transport of dried fine grained sediments is possible during periods of construction.

Potential receptors of contamination are the residents of Milltown and Bonner Junction; the residents of West Riverside, Pinegrove and East Missoula, downstream of the site; and any residents with wells completed in

possibly contaminated ground water, as well as individuals using the reservoir for some form of recreational activity.

Benthic fauna, vegetation, and fish within and downstream of Milltown Reservoir are likely receptors of contaminated surface water or sediments. Decreased diversity of aquatic organisms has been documented downstream of the site on the Clark Fork River as well as occasional fish kills (Section 2.1.6). The exact relationship of fish kills to the Milltown reservoir sediments is not known. Vegetation in floodplain areas of the site is also known to have somewhat elevated metal content. Through bioaccumulation in the food chain, animals/humans who ingest contaminated organisms are potential indirect receptors. Recreational users of the reservoir or river may ingest or contact metals carried by sediments or surface water.

2.2.3 ENVIRONMENTAL AND PUBLIC HEALTH EFFECTS

Elevated levels of metals have been found in ground water supplies in Milltown and in sediments behind Milltown Dam. The primary contaminant in drinking water supplies is arsenic. Sediments contain high levels of arsenic, copper, zinc, manganese, lead, and barium. More details of health and environmental effects can be found in the Preliminary Environmental Assessment (Appendix A).

Exposure to metals occurs via ingestion and skin adsorption. Chronic arsenic exposure is primarily associated with keratosis (skin disease), hyperpigmentation, possibly precancerous dermal lesions, and cardiovascular injury. Ingestion of arsenic has been related to frequent colds and pneumonia in studies conducted in Chile and Taiwan (MONTPirg, 1983). The trivalent form of arsenic may be more toxic than the pentavalent form and is acutely toxic to adult freshwater animals at levels of 812 µg/l (Appendix A). In surface waters, the pentavalent form of arsenic would essentially be the sole arsenic oxidation state.

Copper concentrations in surface waters appear to pose an adverse impact to aquatic life. Copper concentrations, both upstream and downstream of the reservoir, often exceed Ambient Water Quality Criteria during runoff and drawdown periods. Acute toxicity values for freshwater animals range from 7.2 µg/L for Daphnia pulicaria to 10,200 µg/L for bluegill, decreasing as hardness and alkalinity increase. Chronic toxicity to copper for brook trout occurs at 3.9 µg/L. Initial studies upstream on the Clark Fork by MFWP have linked copper with fish kills following storm events and resuspension of floodplain sediments.

2.3 INITIAL REMEDIAL MEASURES

Remedial measures to date include completion of an alternative water supply for Milltown and adjustment of MPC's rate of reservoir drawdown to avoid resuspension of sediments.

2.3.1 REPLACEMENT WATER SUPPLY

In May 1981, four of Milltown's water supply wells, located between Interstate 90 and the Burlington Northern Railway, were found to contain water with arsenic concentrations in excess of 10 times the EPA primary drinking water standard of 0.05 mg/l. On August 20, 1981, residents of Milltown were advised not to use waters from these wells for potable purposes. Initially, the 33 residences supplied from these wells were without a water supply. During 1983, volunteers began supplying residents with imported water on a biweekly basis from a tank truck.

As a result of the RI (Woessner et al., 1984) and the FS for the interim water supply (Peccia, 1983), a site for an alternative water supply was selected in alluvial ground waters recharged by the Blackfoot River. This alternative water supply was brought on line in May 1985.

2.3.2 RESERVOIR DRAWDOWN

Milltown Reservoir has been shown to resuspend reservoir sediments releasing these sediments and associated heavy metals to the Clark Fork River. This resuspension was found to occur most dramatically during operational drawdowns of Milltown Reservoir. Operational drawdowns are necessary to reset spillway flashboards and inspect the facility structures. Reservoir drawdowns for flashboard resetting are on the order of 8 to 9 feet, usually occurring following maximum spring runoff. Deeper drawdowns, 22 to 25 feet, are performed for inspection of the dam's structural units as necessary. The rate of reservoir drawdown was approximately 6 inches per hour prior to 1981. In 1981 a gradual drawdown schedule was implemented to minimize sediment releases to the Clark Fork. MPC is currently modernizing the facility, therefore new drawdown conditions and frequencies should be considered in the FS (see Section 2.1.8).

2.4 PRELIMINARY IDENTIFICATION OF REMEDIAL ACTION ALTERNATIVES

The Feasibility Study will provide the mechanism by which remedial alternatives will be developed, screened, and evaluated. This process will allow for selection of the remedial alternative(s) which are technologically feasible and reliable, which effectively mitigate and minimize damages to, and provide adequate protection of, human health and the environment in a cost-effective manner, and which reduce the toxicity, mobility, and volume of contaminants.

The National Oil and Hazardous Substances Contingency Plan (NCP) specifies that, to the extent it is both possible and appropriate, at least one remedial alternative shall be developed as part of the FS in each of the following categories:

NCP Category	Description
1	Alternatives for treatment or disposal at an off-site facility.
2	Alternatives which attain applicable or relevant and appropriate public health or environmental standards.
3	Alternatives which exceed applicable or relevant and appropriate public health or environmental standards.
4	Alternatives which do not attain applicable or relevant and appropriate public health or environmental standards but will reduce the likelihood of present or future threat from the hazardous substances and which provide significant protection to public health, welfare, and the environment.
5	No action alternative.

In addition to the criteria specified in the NCP, the Superfund Amendments and Reauthorization Act of 1986 (SARA) requires that the following alternatives be developed:

SARA Category	Description
1	Alternatives that, to the degree possible, would eliminate the need for long-term management at the site.
2	Alternatives that would reduce toxicity, mobility, or volume of contaminants.
3	A containment option involving little or no treatment.
4	No action alternative.
5	Alternatives that include alternative or innovative technologies.

To provide a basis for specificity in the Work Plan, a preliminary list of remedial action alternatives was developed for the Milltown Reservoir Sediment site that would comply with both the NCP and SARA criteria. These alternatives are summarized below:

1. **No Action**
   There will be no remedial action taken under this alternative in addition to construction of the alternate water supply system. This alternative will provide the baseline conditions against which the other alternatives will be evaluated. Assessment of public health and environmental risks for this alternative must assume no institutional controls (dam operations; ground water, surface water, and land use) beyond those currently in existence. During dam rehabilitation, MPC is hauling sediments to a temporary disposal area within the boundaries of the Superfund site. The No Action alternative should evaluate the MPC disposal site and other disposal sites for health and environmental risks in the event that No Action is taken.

2. **Institutional Controls**
   This alternative requires the establishment and enforcement of specific ground water, surface water, and land use restrictions; dam operation restrictions; and maintenance of a comprehensive monitoring program. The primary mechanism of ensuring these institutional controls would be through local ordinances. There would be restrictions placed on well construction within the present and future extent of the ground water plume and alternative water supplies would be provided to affected water users. Surface water and land use restrictions would involve limitations to site access, recreational uses (boating, fishing, etc.), and new dwellings or structures. Restrictions on dam operations with respect to the frequency, rate, and depth of reservoir drawdown would be imposed to minimize resuspension and downstream transport of contaminated sediments.

3. **Removal and Disposal of Sediments (without treatment)**
   This alternative involves the complete removal of all contaminated sediments and disposal in a RCRA (or other appropriate) facility or in a regional waste repository. Removal would be achieved through hydraulic and/or mechanical dredging. The river would be diverted temporarily to allow excavation activities to take place. Excavated sediments could be transported to the disposal site via a slurry pipeline or dried and transported in trucks or by conveyor. Dewatering of the sediments can be accomplished through on-site drying beds or by extraction. If extraction is used, the water may have to be treated prior to discharge.

4. **Removal, Treatment, and Disposal of Sediments**
   This alternative involves the complete removal of contaminated sediments, on-site or off-site treatment, and disposal in a non-RCRA type facility. The difference between this and alternative 3 is the on-site or off-site chemical treatment of sediments. Treatment of the excavated sediments can be achieved through addition of solidification agents (cement, kiln dust, fly ash, etc.) or chemical reprocessing. Depending on the type of fixation agent

used, dewatering of the sediments may be necessary before treatment. The resulting water may require treatment prior to discharge.

5. **Sediments Flushing/Stabilization**
This alternative involves injecting clean water or fluids into the sediments to flush contaminants via a series of injection wells or infiltration galleries. The placement of the wells would be such as to minimize impact on the existing clean water supplies. Treatment by flushing would reduce the long-term potential for leaching of contaminants from the sediments under natural conditions.

6. **In-Situ Treatment**
This alternative involves construction of an injection system within the reservoir sediments to perform a variety of in-situ treatments such as chemical injection. Chemicals and/or other fixation agents will be injected to perform chemical treatment include oxidizing or reducing agents to prevent or enhance leaching. Bench-scale treatability studies would be required to determine the most effective treatment technology.

7. **Reservoir Sediment and Channel Stabilization**
This alternative may involve covering, capping, sealing, or grouting of the reservoir sediments and armoring the channel. Temporary diversion of the river channel would be required. Partial removal and dewatering of the fine-grained sediments may be required prior to placing the cap. The cap material could be either asphalt, concrete, soil cement, chemical sealants, synthetic membranes, or a combination. Sealants and grouts may be either injected or used as a covering. Methods for grouting and sealing include hydraulic isolation followed by grouting, in-situ covering and sealing, and in-situ injection. The concept of sediment stabilization may include such temporary measures as excavation during periods when the sediments are frozen to minimize risks of resuspension of contaminated sediments.

8. **Source Control**
This alternative involves the construction of a by-pass channel to isolate the Clark Fork River from the reservoir sediments. Control of sediment loadings to the system above Milltown Reservoir will be considered within the scope of the Silver Bow Creek and Anaconda Smelter NPL sites but outside the scope of the remedial action for the Milltown Reservoir Sediments site. The by-pass channel could be lined to provide scour protection during high flows.

9. **Containment of Contaminated Ground Water**
This alternative involves the use of physical and/or hydraulic barriers to restrict the migration of contaminated ground water from the reservoir sediments. Physical barriers would consist of soil-bentonite slurry, grout curtains, or sheet-pile cutoff walls. The wall would be keyed into impermeable materials at the base and

sides. The hydraulic barrier would consist of a series of injection wells, seepage basins, or infiltration galleries that would create a ground water gradient sufficient to contain the contaminated ground water from the reservoir sediments. The size and placement of the hydraulic and/or physical barrier would be such as to minimize any impact to existing clean water supplies.

10. **Ground Water Extraction and Treatment**
This alternative involves placing a series of pumping wells within the sediments and/or downgradient wells and treating the pumped water prior to discharge into the river. If the wells are placed within the sediments, the low permeability of the sediments will require closely spaced, vacuum-operated well points. An option would be to place pumping wells within the alluvial aquifer underlying the sediments. Downgradient wells can be constructed with a fully screened interval within the saturated portion of the alluvial aquifer. A treatment plant system would be constructed on-site to treat the water.

11. **Dam Engineering**
This alternative consists of two options: (1) complete removal of the dam, and (2) raising the sluiceway and the dam crest. Complete dam removal will involve cofferdamming and removing portions of the dam in sequence. To some extent, the rehabilitation of the dam by Montana Power Company has accomplished the second subalternative, i.e., the maximum reservoir stage has been elevated and the capacity of the reservoir to accumulate sediment has been increased. Montana Power Company is currently rehabilitating the power station and the dam. New operations may make this or other alternatives obsolete.

Finally, the analysis of Alternatives 1, 9 and 10 should assess the results of the Supplementary Site Investigation activities in determining the existence and extent of a contaminated ground water plume downstream and northwest of the Milltown Dam and potential impacts of the No Action or remedial alternatives relative to the Missoula Sole Source Aquifer.

3.0 WORK PLAN RATIONALE

The preliminary work plan tasks presented in this document describe the anticipated scope and direction of proposed activities which will:

1. Enable the human health and environmental risks associated with the presence of hazardous substances, contaminants, and/or pollutants at the Milltown Reservoir Sediment site to be assessed, and

2. Provide for the development of preferred action alternatives which shall correct identified problems.

In order to assess the human health and environmental risks(s) associated with the presence of the various hazardous substances, contaminants, and/or pollutants at the Milltown Reservoir Sediment site, additional focused investigations are necessary. These focused investigations shall provide:

1. The characterization of hazardous substances, contaminants, and/or pollutants at the Milltown Reservoir Sediment site (including identification, concentration, areal extent, mobility, toxicity, etc.).

2. The characterization of the sole source ground water flow system downstream of Milltown Reservoir (including both vertical and lateral hydraulic head distributions, hydraulic conductivities, flow direction and travel time, recharge source identification, and interaction potential with the identified wastes).

3. Characterization of the surface water system in terms of how it is impacted by the presence of sediments in Milltown Reservoir (including transport of surficial contaminants, erosion of protective caps, ground water impacts).

As discussed in Section 2.4, a potential range of remedial alternatives have been identified for further evaluation. Two general operating assumptions apply to the list of alternatives. First, it was assumed that remedial actions may be designed to coincide with completion of upstream remedial actions that would provide source control of surface water inputs

to the Milltown system. Second, the Feasibility Study (FS) is expected to consider combinations of these actions and possibly identify other applicable technologies.

The remedial alternatives would be subject to evaluations of the occurrence of a 100-year (or potentially greater) flood event and the partial and significant failure of upstream sediment control measures.

Additional concerns have also been identified which should be addressed in the FS; these concerns include:

- o Determination of the existence and extent of a contaminated ground water plume downstream and northwest of the Milltown Dam;
- o Determination of potential impacts of the remedial actions relative to the Missoula sole source aquifer;
- o Definition of the full range of reservoir management options that would be relevant to contaminant releases;
- o Evaluation of potential contamination of the replacement water supply well by organic contaminants as well as by arsenic and metals;
- o Development of a suitable Endangerment Assessment (EA) approach that recognizes the spatial limits of the Milltown Sediments site and the amount of source control obtainable through Milltown remedies.
- o An evaluation of the efficacy of Montana Power Co. sediment disposal ponds located southeast of Milltown Dam; and
- o An evaluation of other potential disposal sites for Milltown sediments.

Specific information is needed to properly evaluate the alternatives and concerns. Previous, ongoing, and future studies were reviewed to evaluate the available data for utilization in the FS analysis and to identify if additional information is required. The results of this review are presented in Appendix B of this Work Plan. Specific studies and field investigations needed to collect the additional data were also addressed. The specific objectives of this data evaluation were:

1. Conduct a review of all previous and ongoing studies to identify sources of data relevant to the Milltown FS.

2. List information and data requirements for completion of the FS, while identifying the extent to which existing data may meet the requirements of the FS.

3. Identify the extent to which existing data may satisfy EPA data quality objectives and data validation criteria.

4. Define additional data needs for completion of the FS.

Numerous environmental studies have been or are being performed in the Clark Fork River basin. These studies were reviewed for their applicability to the Milltown Reservoir Sediments Site in terms of providing information in the following areas of concern:

- Ground Water
- Surface Water
- Sediment
- Public Health
- Environment (aquatic life, vegetation, wildlife, wetland, and floodplain assessment)
- Alternative development

Previous studies in the Clark Fork River basin which may provide useful information in evaluating remedial alternatives for the Milltown site have been performed by the University of Montana, Harding Lawson Associates (HLA), the Montana Power Company (MPC), Montana Department of Health and Environmental Sciences - Water Quality Bureau (MDHES-WQB), the Montana Department of Fish, Wildlife, and Parks (MDFWP), the USGS, and others.

All of the studies identified provide valuable information for use in the FS. However, due to the unavailability of specific documentation in many of the reports, the data are generally unsupported by EPA Level A/B quality

assurance criteria. This does not preclude the use of this information in the FS, provided that final selection of an alternative is not solely based on such data.

As for data generated by HLA, later submittals are under review. However, it is assumed in this Work Plan that all HLA laboratory data will eventually be supported by adequate quality assurance documentation and found to be acceptable. If the data does not meet appropriate criteria, the data still may be usable as defined by the Consent Order with the PRPs. Information needs for each of the areas of concern listed above, those studies identified as providing particularly useful information to meet these needs, and an assessment of the technical adequacy of study results for use in the FS are summarized in Tables 3-1 through 3-6.

TABLE 3-1

INFORMATION NEEDS SUMMARY - GROUND WATER

Information Need	Applicable Study	Data Reported	Technical Adequacy
Identification and characterization of sources and major contaminants of concern			
o Reservoir sediments	RI (Woessner, et al., 1984)	o Geophysical logs o Potentiometric maps o Aquifer test results o Reservoir sediment and pore water metals chemistry o Cation/anion and metals o Chemistry for select community wells	Validated data, adequate for source characterization.
	Milltown Reservoir Draft Data Report (HLA, 1987)	o Reservoir sediment soil boring logs and trace metals chemistry	Data will likely meet EPA Level A/B quality assurance criteria, adequate for source characterization.
o Potential contamination of Milltown replacement water supply well	CDM Downstream Screening Study (to be conducted)	o Organics and metals (total) sampling of well	To be conducted under State/EPA approved SAP/QAPP.
o Potential impacts of Champion Pond water	CDM Downstream Screening Study (to be conducted)	o Organics and metals (total and dissolved) sampling of pond	To be conducted under State/EPA approved SAP/QAPP.
Delineation of the areal and vertical extent of ground water	RI (Woessner, et al., 1984)	o Geophysical logs o Potentiometric maps o Aquifer test results	Validated laboratory data, partially adequate for plume delineation.
	Milltown Reservoir Draft Data Report (HLA, 1987)	o Reservoir sediment soil boring logs	Laboratory data will likely meet EPA Level A/B quality assurance criteria, limited plume definition.
	CDM Downstream Screening Study (to be conducted)	o Water levels and metals analysis of domestic wells	To be conducted under State/EPA approved SAP/QAPP.

TABLE 3-1 (cont.)

INFORMATION NEEDS SUMMARY - GROUND WATER

Information Need	Applicable Study	Data Reported	Technical Adequacy
Hydrogeologic and geochemical characteristics of the alluvial aquifer	RI (Woessner, et al., 1984)	o Extensive monitoring well network	Validated data, sufficient spatial coverage upgradient of Dam.
	Milltown Reservoir Draft Data Report (HLA, 1987)	o Two additional monitoring wells	Data will likely meet EPA Level A/B quality assurance criteria, sufficient spatial coverage upgradient of Dam.
	CDM Downstream Screening Study (to be conducted)	o Depth to bedrock from downgradient well logs	To be conducted under State/ EPA approved SAP/QAPP.
Recharge/discharge relationships between ground and surface waters	None		
Identification of potential receptors and well users	RI (Woessner, et al., 1984) and Milltown Reservoir Data Report (HLA, 1987)	o Milltown residents identified	Downstream receptors not identified.
	CDM Downstream Screening Study (to be conducted)	o Well inventory downgradient of Dam o Survey of residents in vicinity of plume	To be conducted under State/ EPA approved SAP/QAPP.
	Sole Source Petition (MCCHD, 1988)	o Missoula dependency on aquifer	
	FS for Interim Water Supply (Peccia, 1983)	o Replacement water supply and distribution	
Characterization of background ground water quality	None		

TABLE 3-2

INFORMATION NEEDS SUMMARY - SURFACE WATER

Information Need	Applicable Study	Data Reported	Technical Adequacy
Characterization of existing surface water regime (quantity and quality)			
o Streamflow/water quality data	Milltown Reservoir Draft Data Report (HLA, 1987)	o Two sampling episodes - flow, total and dissolved metals, TSS	Data will likely meet EPA Level A/B quality assurance criteria.
	Montana Power Company (numerous reports)	o Peak flow frequency analysis o 3/84-12/84 sampling - flow, metals, TSS	Non-validated, but confirmation effort underway.
	MDHES-WQB (various sampling programs)	o River and reservoir flow sampling - flow, metals, TSS, nutrients, field and other parameters	Potentially validated or confirmed.
	USGS (various sampling programs)	o River and reservoir flow sampling - flow, metals, TSS, nutrients, field and other parameters	Non-validated, but confirmation effort underway.
	USEPA STORET Database (1985)	o Flow, metals, TSS, other parameters throughout Clark Fork basin	Due to large number of sources of data, validation, or confirmation unlikely.
o Expected contaminated sediment inflow under failure of upstream sediment controls	Champion International Frenchtown Mill Discharge Permit (Ingman, 1985)	o Flow, TSS, metals at USGS gages upstream of Milltown	Potentially validated or confirmed.
	Rice and Ray (1985)	o One-time sampling of upstream floodplain sediments - total metals	Adequate to provide order of magnitude estimates of loading.
	Source of Metal Contamination in Milltown Reservoir, Montana (Moore, 1985b)	o Upstream streambank sampling - metals and particle size distribution	Adequate to provide order of magnitude estimates of loading.
	USGS (1987)	o Flow, TSS, metals, particle size distribution at 6 USGS gages upstream of Milltown	Potentially confirmed, adequate to provide order of magnitude estimates of loading.
	NURE Program (Braxton, 1980)	o Sediment sampling at 1,944 locations in Clark Fork River basin, some metals analysis (no arsenic)	Adequate to provide order of magnitude estimates of loading.
o 100-year floodplain delineation	Milltown Reservoir and Clark Fork River Sedimentation Study (Curtis, 1985)	o Sediment transport modeling from upstream of reservoir to Missoula	Not validated, useful for informational and calibration purposes.

TABLE 3-2 (cont.)

INFORMATION NEEDS SUMMARY - SURFACE WATER

Information Need	Applicable Study	Data Reported	Technical Adequacy
Characterization of sediment transport processes through Milltown Reservoir			
o General information on flow, water quality, suspended sediment	Studies identified above under "streamflow/water quality data"	o See above	USGS/MPC data subject to confirmation.
	Milltown Reservoir and Clark Fork River Sedimentation Study (Curtis, 1985)	o Topographic and hydrographic surveys	Not validated, useful for informational and calibration purposes.
	Longitudinal Dispersion of Trace Metals in the Clark Fork River Basin, MT (Andrews, 1986)	o Streambed samples from 12 locations on Clark Fork and 5 on tributaries, metals analysis of size fraction	Not validated, useful for information and calibration purposes.
o Characterization of reservoir sediments	RI (Woessner, et al., 1984)	o Geophysical logs o Reservoir sediments and pore water chemistry	Validated data.
	Milltown Reservoir Draft Data Report (HLA, 1987)	o Reservoir sediment soil borings logs and trace metal chemistry	Data will likely meet EPA Level A/B quality assurance criteria.
o Flow/water quality characteristics under drawdown events	Various MPC studies	o Water quality sampling during prior drawdown events and Phase I rehabilitation	Not validated, but confirmation efort underway.
	MDFWP Study (Marcoux, 1970)	o Sampling downstream during 1970 MPC drawdown event, some metals analyzed	Useful for comparison to MPC results.
	University of Montana Master's Thesis (Mehring, 1985)	o Sampling during 1983-1984 drawdown event	Useful for comparison to MPC results.
	CDM Time-Constrained FS Field Investigation (currently underway)	o Concurrent sampling with CLP analyses with USGS/MPC sampling program	Conducted under State/EPA approved SAP/QAPP.
Recharge/discharge relationships between surface and ground waters	Review of Missoula Sole Source Aquifer Petition		To be determined.
Identification of potential receptors of contaminated surface waters	RI (Woessner, et al., 1984) and Milltown Reservoir Draft Data Report (HLA, 1987)	o Milltown residents identified	Downstream receptors not identified. Wildlife and aquatic life receptors not specifically identified.
	CDM Downstream Screening Study (to be conducted)	o Initial screening and sampling of lands irrigated with Clark Fork River water	To be conducted under State/EPA approved SAP/QAPP.

TABLE 3-2 (cont.)

INFORMATION NEEDS SUMMARY - SURFACE WATER

Information Need	Applicable Study	Data Reported	Technical Adequacy
Characterization of background surface water quality	Studies identified above under "streamflow/water quality data"	o See above (particularly sampling stations upstream of Milltown on Blackfoot, Clark Fork, and other tributaries)	USGS data subject of confirmation.

TABLE 3-3

INFORMATION NEEDS SUMMARY - SEDIMENT

Information Need	Applicable Study	Data Reported	Technical Adequacy
Extent of contaminated sediments within the reservoir	Milltown Reservoir Draft Data Report (HLA, 1987)	o Reservoir sediment soil boring logs	Data will likely meet EPA Level A/B quality assurance criteria, adequate for sediment characterization.
	RI (Woessner, et al., 1984)	o Geophysical logs	Validated data.
	MPC evaluation of water resource impacts from dam rehabilitation (Hydrometrics, 1985)	o Detailed well logs for 10 test holes	Useful for comparative purposes.
	University of Montana study of Milltown Reservoir sediments (Udaloy, 1988)	o Stratigraphy of reservoir sediment from monitoring wells grid	Useful for comparative purposes.
Geochemical characterization of reservoir sediments	RI (Woessner, et al., 1984)	o Particle size distributions and sediment and pore water chemistry	Validated data.
	Milltown Reservoir Draft Data Report (HLA, 1987)	o Trace metals analysis of fine-grained reservoir sediments	Data will likely meet EPA Level A/B quality assurance criteria, adequate for sediment characterization.
	MPC evaluation of water resource impacts from dam rehabilitation (Hydrometrics, 1985)	o Total metals, EP toxicity, distilled water extracts for metals for 10 test holes	Useful for comparative purposes.
	Champion International Frenchtown Mill Discharge Permit (Ingman, 1985)	o Reservoir sediment samples analyzed for total and total recoverable metals	Useful for comparative purposes.
	Partitioning of Arsenic and Metals in Reducing Sulfidic Sediments (Moore, et al., in press)	o One reservoir sediment core analyzed for stratigraphy, grain size distribution, pH, and trace metals	Potentially validatable.
	University of Montana Study of Milltown Reservoir sediments (Udolay, ongoing)	o Measured changes in speciation of metals between reduced and oxidized zones within reservoir sediments	Useful for comparative purposes.
Total volume of contaminated sediments	Milltown Reservoir Draft Data Report (HLA, 1987)	o Total volume of contaminated sediments computed using 24 boreholes along 6 transects	Adequate for volume estimation.
Availability of suitable on-site or off-site disposal sites	None		

TABLE 3-4

INFORMATION NEEDS SUMMARY - PUBLIC HEALTH

Information Need	Applicable Study	Data Reported	Technical Adequacy
Toxicity and quantity of hazardous substances			
o Ground water	See Table 3-1 sections Identification ... of source Hydrogeologic and geochem.		
o Surface water	See Table 3-2 sections Charac. of existing surf. Characterization of sediment transport processes Table 3-3 Extent of cont. sediments		
o Sediment	See Table 3-3 sections Extent of cont. sediments Geochem. characterization of reservoir sediments Total volume of cont.		
o Biota	See Table 3-5 sections Toxicological assessment		
Environmental fate and transport mechanisms including exposure pathways			
o Ground water	See Table 3-1 sections Delineation of areal and vertical extent Hydrogeol. and geochem. characteristics of alluvia Recharge/discharge rel. Identification and charac. of sources and major cont.		
o Surface water	See Table 3-2 Charac. of existing surf. Charac. of sediment transport mechanisms Recharge/discharge rel.		
Potential human receptors			
o Ground water	See Table 3-1 section Identification of potential receptors		
o Surface water	See Table 3-2 section Identification of potential receptors		

TABLE 3-4 (cont.)

INFORMATION NEEDS SUMMARY - PUBLIC HEALTH

Information Need	Applicable Study	Data Reported	Technical Adequacy
Quantitative risk assessment	MontPIRG, 1983	o Health survey for Milltown surveyed for illnesses known to be caused by arsenic exp.	
	CDM, 1986	o Preliminary Endangerment Assessment toxic effects of metals listed	

TABLE 3-5

INFORMATION NEEDS SUMMARY - ENVIRONMENTAL ASSESSMENT

Information Need	Applicable Study	Data Reported	Technical Adequacy
Species of concern: Species diversity, abundance, and status			
o Aquatic Wildlife	MDFWP (Marcoux, 1970) MDFWP (Peters, 1981) MDFWP (Peters, 1985)	o Fish inventories at Milltown Site-upstream and downstream of Milltown Dam	
	MDHES-Champion International Discharge Permit Curtis, 1985	o Benthic macroinvertebrate and periphyton plus phytoplankton abudnance: upstream, downstream, and within Milltown Reservoir	
o Vegetation	Curtis, 1985	o Vegetation mapping and community identification Milltown Reservoir and floodplain	
o Wildlife	Curtis, 1985	o Cursory listing of wildlife and potential wildlife in the Milltown area	
Surface Water Quality	See Table 3-2		
Toxicological Assessment			
o Extent of Contamination/ Bioaccumulation	Curtis, 1985	o Metals analysis in plants on Milltown Reservoir floodplain: comparison with toxicity levels and safe dietary levels in animals	
	Phillips, 1985	o Copper and cadmium analysis in fish gill tissues	
	CDM Downstream Screening Study (to be conducted)	o Contamination to soils and plants from irrigation using contaminated surface waters	

TABLE 3-5 (cont.)

INFORMATION NEEDS SUMMARY - ENVIRONMENTAL ASSESSMENT

Information Need	Applicable Study	Data Reported	Technical Adequacy
o Literature Search for toxicological data	Curtis, 1985	o Levels of metals in plants for uncontaminated and contaminated areas: Documentation of critical levels for plants and dietary intake levels for animals	
	CDM, 1986: Environmental Assessment Section found in Appendix A	o Toxic levels in aquatic organisms	
o Biomonitoring	Dodson, et al., undated	o Acute and Chronic toxicity test on Ceriodaphnia for Upper Clark Fork	
	Burton, et al., 1987	o 7-day survival/reprod. tests Ceriodaphnia plus microbial assays of enzyme activity, heterotrophic uptake, and metal resistance to arsenic, copper, and selenium: diatom species number and diversity	
	Marcoux, 1970	o Trout response to drawdown of the Milltown Reservoir: adult and fingerling life stages	
	MDFWP: Champion International Discharge Permit	o Copper uptake by crayfish as indicator organism in sediment settling areas d/s of Milltown	
	USEPA: Champion International Discharge Permit	o Chronic bioassays using Ceriodaphnia, juvenile rainbow trout and a water flea on the Clark Fork	
o Habitat evaluation	Curtis, 1985	o Evaluation of plant communities by soil saturation and grain size: Habitat issues in reintroducing the Canada Goose to Milltown Reservoir	
	MDFWP, 1986	o Application for instream low flows on the Upper Clark Fork River using the wetted perimeter technique	

TABLE 3-6

INFORMATION NEEDS SUMMARY - ALTERNATIVE DEVELOPMENT

Information Need	Applicable Study	Data Reported	Technical Adequacy
MPC plans for future operations of Milltown	None		
o Reservoir drawdown schedulng, frequency, magnitude			
o Reservoir area - capacity curves			
o Spillway - outlet discharge rating curves			
Potential disposal sites	None		
o Locations			
o Transportation options			
o Site capacities			
o Site characterization - soils and ground water			
o Adequate monitoring program			
o Health risks			
Channel by-pass routing and design data	None		
o Detailed topographic mapping			
o Geotechnical data for stability and depth to bedrock			
o Design flows for channels			
Dam engineering data for siting of enlarged dam	None		
o Detailed topographic and geologic mapping			
o Geotechnical engineering data			

TABLE 3-6 (cont.)

INFORMATION NEEDS SUMMARY - ALTERNATIVE DEVELOPMENT

Information Need	Applicable Study	Data Reported	Technical Adequacy
Efficacy of MPC sediment disposal ponds (for dam rehabilitation)	None		
o Pond locations			
o Removal/disposal methods			
o Volume and chemical characterization of removed sediments			
o Protective measures used to prevent resuspension of disposed sediments			
Sediment treatment technologies	None		
o Fixation agent(s)			
o Chemical reprocessing			
o Bench-scale treatability studies			
Ground water containment methods	None		
o Physical versus hydraulic barriers			
o Types of physical/hydraulic barriers			

4.0 SUPPLEMENTARY SITE INVESTIGATION ACTIVITIES

Based on a review of existing information and data, additional data (Section 3.1) will be needed to complete an evaluation of potential alternatives in the FS. The following sections describe tasks that are defined to address each additional data requirement for the FS. These tasks may be modified in the FS Work Plan pending discussion between MDHES, EPA, and the PRPs regarding the use of existing data.

4.1 TASK 1.0 - PROJECT PLANNING

Project planning includes project scoping, the development of Supplementary Site Investigation Activities and FS support documents, and a site survey. Standard Operating Procedures should be developed to (1) ensure that data collected during this effort are technically accurate, precise, complete, comparable, representative of field conditions, and legally defensible; (2) provide adequate protection for on-site personnel during field activities; (3) inform the public of ongoing activities; and (4) assure the accuracy, precision, completeness, and comparability of analytical efforts. Detailed descriptions of these procedures will be included in the Health and Safety Plan (HSP), Sampling and Analysis Plan (SAP), Community Relations Plan (CRP), and Quality Assurance Plan (QAP).

4.1.1 SUBTASK 1.1 - PROJECT SCOPING

Project scoping is the first step in project planning. The scoping process is an iterative one which will continue through the FS process. When new data are acquired or new decisions are made, site-specific data requirements will be reevaluated and the scope may be modified. During scoping, data needs, data acquisition methods, and data evaluation methods may be further refined. Scoping will include any necessary meetings and site visits held early in the FS process to better define site conditions and project goals. All available site data must be collected. Any

additional available data for the site not evaluated already (see Section 3.0), must be gathered and evaluated as part of the scoping task. It is important to note that much of the FS scoping has been completed, including the Remedial Investigation for ground water contamination assessment; identification of potential remedial alternatives (Section 2.4); initial evaluation of existing data and data needs (Section 3.0); and preliminary identification of ARARs (Section 5.0).

4.1.2 SUBTASK 1.2 - HEALTH AND SAFETY PLAN

A detailed site-specific Health and Safety Plan will be prepared upon approval of the Work Plan. This plan will be developed according to regulations and guidelines promulgated by the Occupational Safety and Health Administration (OSHA) (29 CFR, Part 1910), the National Institute for Occupational Safety and Health, the U.S. EPA, and the American Conference of Governmental and Industrial Hygienists. Development and implementation of the HSP should be administered by occupational health professionals trained and certified to perform health and safety functions. The plan will govern all on- and off-site activities for all personnel and subcontractors during the course of the RI/FS. The HSP must address the potential for public exposure to contamination resulting from sampling activities and must be based on available site data. The plan should include site maps, a site description, and results of previous sampling activities. The following elements should be included in the plan:

- The names of a site health and safety officer and other key personnel responsible for site health and safety.
- A health and safety risk analysis for existing site conditions and for each site task.
- A description of employee training.
- A description of personnel protective equipment.
- A description of medical surveillance requirements.

- An indication of the frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation.
- A description of site control measures.
- A description of personnel decontamination procedures.
- A contingency plan.

The HSP should include a medical monitoring program with physical, physiologic, and metabolic function testing being performed by occupational health physicians. All on-site personnel should be entered into a medical monitoring program and be cleared to perform site functions by an occupational health physician. A training program to ensure safe conduct for on-site sampling and remedial action activities should also be implemented. This training should include classroom and simulated field activities.

4.1.3 SUBTASK 1.3 - SAMPLING AND ANALYSIS PLAN

A detailed Sampling and Analysis Plan for Supplementary Site Investigation Activities will be prepared prior to initiation of any field investigations. All field activities must be described in the SAP. The proposed field activities include the collection of ground water, surface water, and sediment samples; monitoring well installation; aquifer testing; measurement of surface water flows; measurement of process water flows; water level monitoring; and geochemical column and batch tests. All sample collection and measurement protocols must be described in detail in the SAP. The SAP should be developed in accordance with appropriate guidance (EPA, 1988) and submitted to the Montana Department of Health and Environmental Sciences (MDHES) and EPA. The plan should include procedures for decontamination of sampling equipment; sample labeling; sample preservation; sealing, storage, and shipping of sample containers; documentation; and chain-of-custody. Analytical methods to be utilized must also be identified in the SAP. The plan should include description of sampling equipment, sample containers, drilling methods, borehole logging

procedures, monitoring well design, and well development procedures. The SAP may be revised as necessary as the need for different types of field activities is reassessed and rescoped. The SAP will be reviewed by MDHES. No field investigation activities may begin until the plan is approved.

In addition to development of the SAP, support activities will be performed as necessary before field investigations begin. Typical activities are:

- o Site access activities and aquisition of well permits.
- o Procurement of subcontractors such as drillers, excavators, surveyors, and geophysicists.
- o Procurement of equipment and supplies.
- o Coordination with analytical laboratories, including sample scheduling and sample bottle acquisition, and procurement of close support laboratories or other in-field analytical capabilities.
- o Procurement of on-site facilities for office space; for performing chemical analyses, decontamination, equipment and vehicle maintenance and repair, and sample storage; and on-site water, electric, telephone, and sanitary utilities.
- o Establishment of on-site facilities for storage or disposal of contaminated material (i.e., decontamination solutions, disposable equipment, drilling muds and cuttings, well-development fluids, well-purging water, and spill-contaminated materials).

4.1.4 SUBTASK 1.4 - SITE MANAGEMENT PLAN

A Site Management Plan (SMP) will be prepared which details operating procedures used to minimize exposure risks and/or the spread of contamination during field investigations. The plan should include:

- o Description of the division of the investigative area into discrete work zones.
- o Protocol for decontamination of field equipment.
- o Procedures for site security and access.

Strict adherence to the conditions imposed by the SMP will be required of all on-site personnel to ensure efficient and safe field operations. Procedures presented in other project-specific plans may be referenced, where appropriate.

4.1.5 SUBTASK 1.5 - QUALITY ASSURANCE PLAN

The Quality Assurance Plan will describe policies, quality assurance, and quality control protocols necessary to achieve Data Quality Objectives (DQOs). The QAP will describe:

- o QA objectives for measurement
- o Sampling procedures
- o Field activity documentation, including records of sample preservation and transport, project log books/field logs, and data collection logs
- o Sample custody
- o Sample management/tracking
- o Instrument performance and calibration procedures
- o Analytical procedures/laboratory QA/QC protocol
- o Data reduction, validation, and reporting
- o Internal QC
- o Performance and systems audits
- o Preventative maintenance
- o Data assessment procedures
- o Corrective actions
- o QA reports

QA/QC procedures are designed to assure the accuracy, precision, completeness, comparability, and representativeness of data collected

during field investigations. Field QC requirements such as sample blanks, duplicates, and travel blanks will also be identified in the QAP.

4.1.6 SUBTASK 1.6 - DATA MANAGEMENT PLAN

Since extensive information will be generated during the FS, a Data Management Plan (DMP) will be prepared. The DMP documents the procedures to be followed for the inventory, control, filing, storage, and retrieval of data collected and reports generated during the FS. Data management procedures should be designed such that the integrity of the data collected is maintained for subsequent use. Project tracking data should be similarly maintained. The DQOs which are established will govern the data management method(s) used and the level of review to which the data are subjected.

Data should be maintained in a standardized form to promote easy updating. Precautions should be taken to prevent introduction of errors or loss of data. The plan should include a description of the project file structure and document inventory control; a description of procedures controlling the receipt, tracking, access and distribution of all data, reports, and records generated; and a description of the data storage system. All data generated by contractors and laboratories, including laboratory documentation, should be maintained in one central location. Procedures for data review and validation should also be described in the plan.

Other project-specific plans may be referenced, where appropriate, in the DMP. The data should be stored and reported in a format compatible with the Clark Fork Data Management System and Geographic Information System operated by the Solid and Hazardous Waste Bureau of the Montana Department of Health and Environmental Sciences.

A data base record of sample shipments, receipt of analytical results, submittal or preliminary results for QA/QC review, completion of QA/QC review, and evaluation of the QC package should be maintained to ensure

that only final and approved analytical data are used in the site analysis. In some instances, the use of preliminary data is warranted to prepare internal review documents and to begin data analysis while minimizing lost time for the turnaround of QA/QC comments. Preliminary data are considered unofficial. Until the QA/QC package is complete, any preliminary data used in analysis must be updated upon receipt of official QA/QC comments and changes. Sample results should not be released unless accompanied by QA/QC comments.

The data quality objectives stated for each task involving sample analysis must specify whether the information is valid with qualifiers or not and must specify which qualifiers can invalidate use of certain data. For instance, reproducibility of plus or minus 20 percent may be acceptable in a treatability study but may not be acceptable for determining treatment for establishing a drinking water standard. Acceptability of data quality is not established until the reviewed QA/QC package accompanies the analytical data.

4.1.7 SUBTASK 1.7 - SITE SURVEY

The PRPs will produce a current, large-scale (e.g., 1 inch = 200 feet) topographic base map covering the entire site area and showing all pertinent features and sampling locations. The map will be used during the FS to help assess remedial alternatives. Such a map will be prepared from aerial photography or site-specific surveys. The map should encompass sufficient area surrounding the site so that any off-site sampling locations can be located. All sampling locations developed during the RI/FS will be surveyed by a land surveyor. The base map(s) will be used for all maps prepared in conjunction with the RI/FS reports.

4.2 TASK 2.0 - COMMUNITY RELATIONS SUPPORT

A community relations program will be implemented by MDHES or EPA with support, as necessary of its Contractor during the FS which makes

information about the site available to the community and gives citizens the opportunity to participate in and comment on decisions concerning the site. The purpose of the program is to involve the community and other interested persons in the decision-making process by establishing the accurate and timely release of information to interested citizens and public officials and encouraging two-way communication between MDHES, Potentially Responsible Parties (PRPs), and the community. The community relations program will require close coordination among local, State, and Federal officials.

4.2.1 SUBTASK 2.1 - COMMUNITY RELATIONS PLAN

A Community Relations Plan will be finalized by MDHES or its Contractor. This plan documents the community relations history of the site and issues of community concern. The plan describes the techniques to be utilized to achieve the objectives of the overall community relations program. A draft plan has been prepared in accordance with applicable guidance (EPA, 1988). The plan includes a description of site background and history; an update of local community concerns about the site; procedures for addressing those concerns; procedures for keeping the public informed and involved; and methods for focusing and resolving potential controversy. Appropriate individuals to be contacted when community relations problems arise are identified in the plan.

4.2.2 SUBTASK 2.2 - PUBLIC MEETINGS

Public information meetings will be held at MDHES's direction at the beginning and periodically throughout the FS. These meetings will be held to update residents on the progress of the FS. Public meetings will also be held to receive comments on the FS report during a minimum 21-day public comment period.

4.2.3 SUBTASK 2.3 - SUPPORT ACTIVITIES

Support activities will include all other activities involved in implementing the community relations program. Fact sheets will be prepared by MDHES or its contractor and distributed to the community during the FS. These will describe up-to-date progress on the FS and project plans.

4.3 TASK 3.0 - INVENTORY OF POTENTIALLY PROTECTED RESOURCES

EPA is required to evaluate the impact of proposed CERCLA actions upon certain resources protected under various Federal and State requirements. More specifically, these resources include historic and cultural resources, endangered species, wetlands, and floodplains. The requirements pertaining to these resources all begin with an initial stage of basic data gathering for identifying the presence of protected resources or the type of resources at a site. The purpose of Task 3 is to inventory the potentially protected resources present at the site and to initiate this data gathering process as early as possible. The following activities are required.

4.3.1 SUBTASK 3.1 - CULTURAL RESOURCES ASSESSMENT

The National Historic Preservation Act and 36 CFR Part 800 (Regulations of the Advisory Council on Historic Preservation Governing the Section 106 Review Process) provide the guidance for determining specific requirements with respect to the preservation of cultural resources. Basically, this requirement involves assessing the suitability of a site for inclusion in the National Register of Historic Places (Register) and/or evaluating the impact of proposed activities on cultural resources present at the site.

Assessing the suitability of a site for inclusion in the Register is accomplished by receiving the State Historic Preservation Officer's (SHPO) consultation or concurrence with a determination of eligibility. Should a site be determined ineligible for inclusion, no further cultural resources work is necessary. On the other hand, if the site is determined to be

eligible for inclusion, any further action at the site must be assessed (prior to initiating the action) as to its potential effect on those resources. Assessing such impacts is accomplished by receiving the SHPO's consultation or concurrence with a determination of effect.

The next step in the cultural resources assessment process is to provide the documentation necessary to support a determination of eligibility. Following completion of the field survey, a Montana Historical and Archaeological Inventory Form and a historical and architectural report will be completed, and a draft determination of eligibility will be submitted to MDHES and EPA for review and approval. Upon approval by MDHES, MDHES shall forward the document to the SHPO for concurrence.

The final step in the cultural resources assessment process is to complete a determination of effect for those features which have been identified as eligible for inclusion on the Register. In the event it is necessary to sample or otherwise disturb any site feature found to be eligible for inclusion on the Register, a determination of effect shall be prepared and submitted to MDHES and EPA for review and approval. MDHES shall forward the determination of effect document to the SHPO for concurrence.

The cultural resources assessment process will require coordination with the SHPO and the Advisory Council on Historic Preservation to prevent project delays.

4.3.2 SUBTASK 3.2 - ENDANGERED SPECIES

Under Section 7 of the Endangered Species Act of 1973, the EPA is required to consult with the U.S. Fish and Wildlife Service (USFWS) regarding Federal actions that may affect endangered species or designated critical habitat for endangered species (16 USC, Section 1531; 40 CFR, Subsection 6.203(h), and 40 CFR, Part 402). On request, the USFWS Office of Endangered Species will provide a list of threatened, endangered, or candidate species that may potentially occur in the area and identify the

location of designated "critical" habitat. If habitat for such species may be affected by the remedial alternatives, then the PRP may be required to conduct a biological assessment to assist the USFWS in determining whether the remedial actions may affect a threatened or endangered species.

4.3.3 SUBTASK 3.3 - WETLANDS ASSESSMENT

Section 404 of the Clean Water Act has been identified as a potential ARAR for the Milltown Reservoir Sediments site. In addition, the Protection of Wetlands Executive Order (E.O. 11990), the Floodplain Management Executive Order (E.O. 11988), Appendix A of 40 CFR Part 6 (Statement of Procedures on Floodplain Management and Wetland Protection), CERCLA FS guidance, and specific CERCLA guidance (Policy on Floodplains and Wetland Assessments for CERCLA Actions, 1985) require procedures for the protection of floodplain and wetland values. The steps necessary to comply with these requirements include (1) a determination of whether floodplains or wetlands are affected by the alternative, (2) assessment of impacts and identification of remedies that avoid or minimize impacts, and (3) public notice and comment.

The delineation of wetlands as part of the waters of the United States will be approached through detailed mapping of the areas potentially affected by remedial alternatives in consultation with the U.S. Army Corps of Engineers (COE) and the USFWS. Mapping will be consistent with COE criteria for delineation of wetlands and will also include mapping unit classification consistent with the USFWS national wetland mapping program (Cowardin et al., 1979). Assessment of floodplain impacts will require the identification of the 100-year floodplain.

4.4 TASK 4.0 - GROUND WATER INVESTIGATION

The ground water investigation involves collection of data to evaluate remedial alternatives (No Action, Ground Water Extraction/Treatment, and Ground Water Containment).

The data to be collected are required to define the conceptual model of ground water flow and contaminant transport at the site. Simple ground water flow and contaminant transport analyses will then be used to assess the effects of the remedial alternatives on ground water flow and quality and surface water quality. A description of the proposed simple models to be used is included in Section 4.4.5.3.

The information needed to fully characterize the contamination and to evaluate alternatives includes the following:

- o Identification and characterization of sources and major contaminants of concern.
- o Delineation of the areal and vertical extent of ground water contamination.
- o Hydrogeologic and geochemical characterization of the alluvial aquifer including recharge from the reservoir sediments.
- o Characterization of the recharge/discharge relationship between contaminated ground water and the surface water of the lower Clark Fork River.
- o Identification of potential human and aquatic receptors.
- o Characterization of background ground water quality.

4.4.1 SUBTASK 4.1 - SOURCE CHARACTERIZATION

Objectives

There are two objectives for this subtask:

- o To identify the potential impacts of organics contamination on the Milltown replacement water supply well by the Champion International pond.
- o To determine the metals concentration and EP toxicity of materials deposited in the Milltown Dam Rehabilitation Waste Disposal site, and identify potential impacts of maintaining this facility in its present location.

Previous Investigations

The Remedial Investigation for the site (Woessner et al., 1984) has adequately defined the reservoir sediments as the major source of arsenic and metals contamination in the ground water. Flow paths and contaminant concentration gradients have been clearly established as originating from the reservoir sediments based on water level and water quality data provided in the RI report (Woessner et al., 1984) for the period February 1982 through June 1984. Similar conclusions can be made using ground water data gathered by HLA (1987) during their supplemental field investigations. Although the HLA (1987) data have not yet undergone data validation, data from the RI have been validated and are adequate for source characterization. HLA data may become validated in the future. However, the potential contamination of existing water supply wells by organic contaminants and the impact of the Champion International pond have not been assessed.

Materials deposited in the waste disposal site are comprised of contaminated spoils consisting of reservoir sediments and structural materials (timbers, etc.) that have been in close contact with the metal laden sediments for approximately eighty years. Representatives of Montana Power Company collected 17 samples from waste material as it was placed in the disposal site (Curtis, 1988). Samples are being analyzed for total metals and EP toxicity. At this writing, results are pending until all analyses are completed.

Scope of Work

CDM has conducted a sampling program of selected existing wells in the vicinity of the Champion pond and of the Champion pond water as part of the Downstream Screening Study. Results are not available at this time as the data are currently being analyzed. The Milltown replacement water supply well was sampled. The sampling program was conducted to identify existing or potential future contamination in the replacement water supply

well. Water quality analyses will include PAHs, PCPs, and dioxins/furans in addition to dissolved and total metals.

The wells sampled and the parameters analyzed are specified in a Sampling and Analysis Plan (SAP). This sampling was conducted in the fall of 1988 by CDM. Samples were analyzed for volatile and semi-volatile organic constituents. Water levels were also measured at this time.

The PRPs shall also conduct a sampling program of materials in the waste disposal site. The sampling design shall be comprehensive enough to verify results of MPC's sampling program and confirm contents of materials buried within the disposal facility. A ground water flow map shall be constructed for the area encompassing the disposal facility. Utilizing existing wells and reservoir pool evaluations, an adequate number of monitoring wells or sand points shall be constructed and surveyed to accurately establish the direction of ground water flow through this area. Construction of a potentiometric map will aid in determining the direction in which potential contamination originating from the waste facility would move. Such information would facilitate monitoring or impacts to the ground water should seepage occur.

Reporting

The water quality analyses for pond water and well samples will be made available for use in FS development. Sampling procedures will be documented, including QA/QC methods and samples. If organics are present in existing wells, the potential source will be discussed. The water levels and chemical analyses will be used to infer the source.

The following information from the waste disposal site sampling program will be provided for inclusion in the FS:

- Results of solid matrix samples from the Waste Disposal Facility.

- o A potentiometric map showing ground water flow through the Waste Disposal Area.
- o A map with locations of existing wells and new monitoring wells or sand points with survey locations and well construction diagrams.

4.4.2 SUBTASK 4.2 - PLUME DELINEATION

Objectives

The objective is to further define the horizontal and vertical extent of the arsenic plume downgradient of the reservoir sediments. The study area for this phase is limited to the area northwest of the Blackfoot River and east of the intersection of Highway 10 and I-90. The study area is currently limited to this area because previous investigations (HLA, 1986) indicate that the plume has not migrated outside of this area. The horizontal and vertical extent of the plume is needed to assess the volume of contaminated water and the feasibility of remedial alternatives (e.g., pumping and treating, hydraulic barrier, etc.).

Previous Investigations

The areal extent of the ground water contamination has been characterized to a certain degree during both the RI (Woessner, et al., 1984) and the draft FS (HLA, 1986). Sampling conducted during the FS was limited in spatial extent due to low reservoir stage. The result was that many wells in the plume vicinity were dry. The plume is not clearly defined along the interstate highway to the west of the Blackfoot River and north of the Clark Fork River.

The vertical extent of contamination has not been defined downgradient of the reservoir in the study area. Only one multiple completion monitoring well exists in the vicinity of the plume (west of the Blackfoot River). Domestic wells are typically unscreened and open only at the bottom. The

well logs for these wells are not currently available, but are being collected as part of the Downstream Screening Study (well inventory) being conducted by MDHES.

Scope of Work

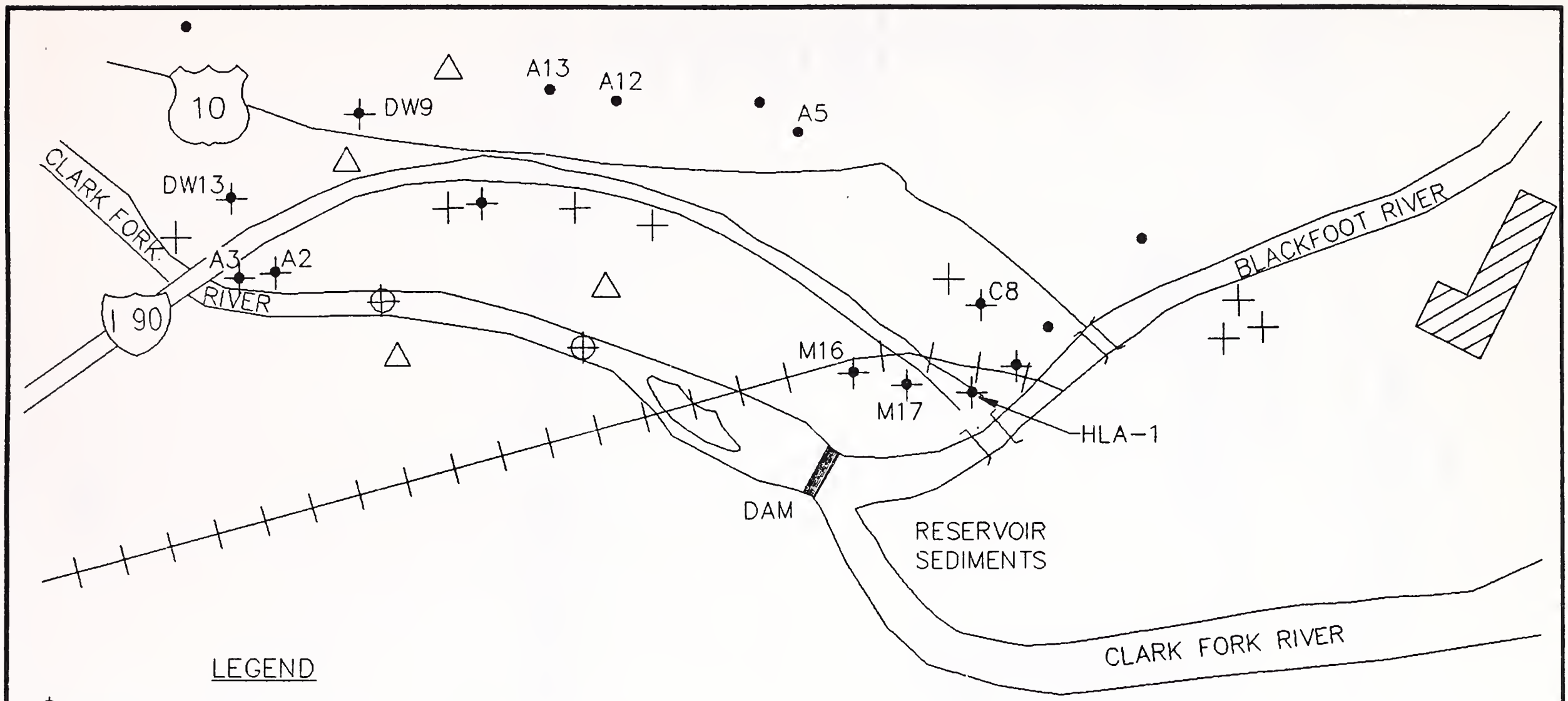
The following activities will be conducted by the PRP in order to delineate the plume:

- Resampling of domestic and monitoring wells in the study area defined in Section 4.4.2.1. Approximately 15 existing wells (shown in Figure 4-1) will be resampled by MDHES or its contractor during the Downstream Screening Study. If these wells are not usable for sampling (due to access or technical problems), other available wells will be identified and sampled. The purpose of this sampling is to establish the current areal extent of the plume. A new plume map will be constructed by MDHES or its contractor based on sampling results. Water levels in wells will also be measured. Parameters to be analyzed are given in Table 4-1.

- Additional monitoring wells will be installed in the vicinity of the downgradient portion of the plume by the PRPs. Due to a lack of information on the full vertical extent of contamination, monitoring well installation will be conducted in two phases. Phase I will be comprised of installation of one nest of 3 wells completed through the upper, middle and lower thirds of the saturated zone within the alluvial aquifer. This saturated zone extends from at least 25 to 60 feet (based on information from wells HLA-1 and HLA-2). The well nest should be located based on the results obtained from the resampling of wells described above. These nested wells should be located near the farthest downgradient extent of contamination along the appropriate centerline of the plume. Installation of the wells in Phase II will be contingent upon the results of resampling of existing wells and the Phase I wells. Locations of Phase II wells will be based on the updated plume configuration described above. Preliminary locations for five new, multiple completion wells are given in Figure 4-1. Depth intervals will be selected based upon the results of the Phase I investigation. The drilling methods will be described in the SAP. A transect normal to the furthest downgradient extent of the plume should be established (Figure 4-1) to establish the horizontal and vertical extent of contamination and to provide information necessary to quantify the recharge/discharge relationship described in Section 4.4.4.

- Sampling of new monitoring wells and water level measurements.

- Surveying of horizontal and vertical locations of new wells.



LEGEND

⊕ PROPOSED STAFF GAGE LOCATION

△ PROPOSED PHASE II NESTED WELLS TO BE INSTALLED CONTINGENT UPON RESULTS FROM RESAMPLING OF DOMESTIC WELLS AND PHASE I WELLS

• WELLS SAMPLED BY HLA

+ DOMESTIC WELLS PROPOSED FOR SAMPLING

0 3000

SCALE: IN FEET

ORIGINAL SOURCE: HLA(1987)

PROPOSED GROUNDWATER MONITORING PROGRAM

CAMP DRESSER & McKEE
RIVERPOINT
2300 15th STREET, SUITE 400
DENVER, COLORADO 80202

CDM

FIGURE NO. 4-1

TABLE 4-1

GROUND WATER ANALYSES

Total and Dissolved Metals	Major Anions	Others[a]
Aluminum	Carbonate/Bicarbonate	pH (laboratory and field)
Antimony	Chloride	Specific Conductance (laboratory and field)
Arsenic	Sulfate	Total Dissolve Solids
Barium		Hardness (calculated)
Beryllium		Temperature (field)
Cadmium		Acidity/Alkalinity
Calcium		Redox potential
Chromium		Arsenic 3^+/Arsenic 5^+ Speciation
Cobalt		Fe^{2+}/Fe^{3+} Speciation
Copper		
Iron		
Lead		
Magnesium		
Manganese		
Nickel		
Potassium		
Selenium		
Silver		
Sodium		
Thallium		
Tin		
Vanadium		
Zinc		

[a] For Subtask 4.1, specifically the Milltown replacement water supply well, analyses will include PAHs, PCBs, and dioxins/furans.

Reporting

The following information will be included in the Supplemental Site Investigation Activities Report:

- o A contour map showing the new plume configuration, with an associated piezometric contour map.
- o Locations of all new monitoring wells, with survey locations and well construction diagrams.
- o Sampling results for wells.
- o A cross-section showing the vertical extent of contamination.

4.4.3 SUBTASK 4.3 - HYDROGEOLOGIC AND GEOCHEMICAL CHARACTERIZATION

Objectives

The objectives of this investigation are to establish a model of the ground water flow and contaminant transport system in the alluvium downgradient of the sediments. The study area for Phase I is defined in Section 4.4.2. The study area is defined as such because it appears that the contaminant plume in the alluvium may be discharging to the Clark Fork River in the vicinity of the intersection of I-90 and Highway 10. The investigations described in Section 4.4.2 (Plume Delineation) and Section 4.4.4 (Recharge/Discharge Relationship) are designed to determine if the plume is discharging to the Clark Fork River or if the plume will move downgradient in the alluvium. Knowledge of hydrogeologic and geochemical properties is necessary to perform simple modeling of contaminant transport. The modeling will be used to estimate exposure point concentrations for receptors using alluvial wells and for aquatic life in the reach of the Clark Fork River affected by the alluvial plume.

Previous Investigations

The extensive monitoring well network established during the RI (Woessner, et al., 1984) and the two additional monitoring wells installed by HLA (1987) should provide sufficient spatial coverage upgradient of the Milltown Dam. However, water level data are required further downgradient to map the major flow pathways originating from the reservoir and to determine the vertical head distribution in the aquifer.

Information regarding depth to bedrock is available from well logs provided in the RI and draft FS reports and from domestic well drillers logs to be obtained during the Downstream Screening Study.

Aquifer tests conducted during the RI indicate a wide range in transmissivities in the alluvial aquifer (55,000 to 4,600,000 ft^2/day). A review of the data collected from these tests shows that the aquifer is highly transmissive, and therefore performance of reliable slug tests or aquifer pumping tests would be difficult.

Scope of Work

Information necessary to characterize the Milltown site hydrogeology and geochemistry includes water levels, aquifer thickness and extent, hydraulic properties of the sediments and the aquifer, and geochemical data. The following activities are required to obtain this information:

- Water level measurements will be obtained for wells in the vicinity of the existing plume.

Water levels will be measured in the existing wells given in Figure 4-1. If, after analysis of the Phase I data, it appears that the plume is moving downgradient of the study area in the alluvium, then Phase II will ensue. Phase II will involve water level measurements in existing domestic wells located between the intersection of I-90 and Highway 10, and Hellgate Canyon.

- Assessment of Aquifer Thickness and Extent

  In Phase I, the existing domestic, water supply, and monitoring well logs will be used by MDHES or its contractor to draw cross sections of the alluvial aquifer. The new monitoring wells will also be utilized. The depth to bedrock and extent of alluvium is needed to estimate flow volumes in the alluvium and to evaluate remedial alternatives.

  Phase II would involve interpretation of logs from existing domestic wells between the dam and Hellgate Canyon. These wells would be utilized to obtain water levels and map the aquifer thickness and extent. Phase II tasks would only be implemented if Phase I indicates that the plume is moving downgradient in the alluvium.

- Aquifer Test

  Hydraulic conductivity values are a critical data need for computing total ground water flux through the alluvial system. The values obtained in the RI and FS range over three orders of magnitude. This wide range in hydraulic conductivity values was due to the highly transmissive nature of the alluvial aquifer and the fast drawdown recovery response time in previous aquifer pumping tests conducted at the site. Therefore, a borehole dilution test will be conducted to obtain a more precise value. A comprehensive review of the method is given by Drost et al. (1968). This test is valid for ground water flow velocities in the range of 0.01 to a few hundred meters per day for which the flow is laminar (Davis et al. 1985). Calculations of velocities in the alluvial aquifer using water level measurements by HLA (1987) and the range of hydraulic conductivity values estimated by Woessner et al. (1984) indicate velocities in the range of 1 to 10 meters per day. Therefore, this method is valid for measurement of hydraulic conductivity of the alluvial aquifer. Use of this method will require installation of a borehole and a set of three observation piezometers to form a triangulation pattern around the borehole. Velocities computed from the borehole can be used to back calculate a range of hydraulic conductivities using the hydraulic head differences observed in the observation wells.

- Infiltration Capacity

  Evaluation of the technical feasibility of the ground water containment alternative using infiltration trenches will require field-scale estimates of the infiltration capacity of the aquifer. Infiltration capacity is the limiting factor that may make this alternative infeasible. A pilot trench infiltration test will be required to measure the long-term infiltration rate of the actual system.

- o Geochemical characterization of the alluvial aquifer will be required to predict the rates of contaminant plume migration under the No Action alternative. The major mechanisms believed to control As solubility in the subsurface are sorption and precipitation reactions. Sorption is one of the major processes controlling migration of arsenic and trace metals in the ground water. Quantification of the adsorption process will require measurement of partition coefficients (Kd) from batch shaker tests in the laboratory. Samples will be required from uncontaminated portions of the alluvial aquifer to be used in these tests. Source water will be obtained from one of the wells in the most contaminated area below the reservoir sediments. The tests will provide representative values of Kd's for arsenic and other major contaminants of concern. Precipitation reactions may be evaluated by passing epoxy resin through the column, allowing it to solidify and then preparing thin sections for petrographic examination from the solidified material. A comparison of pre- and post-run mineralogies will allow for determination of precipitation/dissolution reactions. The Kd values and mineral solubility information will be used directly in the simple contaminant transport model to estimate future concentrations of the plume. This will provide exposure point concentrations for human and aquatic receptors.

Reporting

The following items will be provided by the PRPs from this investigation:

- o Vertical and horizontal piezometric maps of the Phase I study area defined in Section 4.4.2.1.
- o Geologic cross-sections based on the well logs and previous investigations.
- o Results of the borehole dilution test.
- o Results of geochemical analyses. This will include Kd values from batch and column tests.
- o Results of laboratory and modeling efforts.

4.4.4 SUBTASK 4.4 - RECHARGE/DISCHARGE RELATIONSHIPS

Objectives

The objective of this investigation is to establish the recharge/discharge relationship between the Clark Fork River and the alluvial aquifer in the study area.

Previous Investigations

There is no information available on the relationship between ground water and surface water downgradient of the dam. Discharge of contaminated ground water into the Clark Fork River could be a significant migration pathway under the no action alternative.

Scope of Work

Flux estimates of the ground water contribution to surface water can be made by measuring the hydraulic head distribution in ground water across selected reaches of the river. A set of nested wells will be installed in a transect across the river. The transect will be established at the downgradient extent of the arsenic plume (after it is established by resampling), to determine whether ground water is discharging to surface water in this area. Piezometric data from the draft FS (HLA 1987) indicate that this may be occurring.

A well transect (of three nested wells) will be installed at the downgradient extent of the plume, as determined by sampling conducted in the CDM Downstream Screening Study. In addition, two wells will be installed slightly upgradient of the transect. These wells have been previously described in Section 4.4.2.3 (Additional Wells). The wells will help determine the recharge/discharge relationship as well as define the downgradient extent of the plume. If it appears that the plume is

migrating further downgradient in the alluvium, additional transects located between the dam and Hellgate Canyon may be required during Phase II.

Staff gages will be installed on the Clark Fork River at the locations shown on Figure 4-1. The staff gages will be used to establish flow volumes in the Clark Fork River, in order to estimate the potential effect of the contaminant plume on the Clark Fork River. Flow measurements will be obtained across the Clark Fork River at the staff gage locations, if feasible. Due to the high flows normally encountered in the Clark Fork River, accurate flow measurements may be difficult to obtain. The staff gages will also be used to establish the piezometric relationship between the Clark Fork River and alluvial aquifer. A flow net can be constructed using these measurements, and if feasible, seepage meters will be installed in the river bed to quantify ground water discharge. The staff gages will be surveyed.

- o Measurement of water levels in the new nested monitoring wells will take place concurrently with measurement of water levels at the staff gage. Water levels will be measured at least quarterly with monthly measurements preferred to quantify all flow impacts.

- o Water quality samples will be collected concurrently in the new nested monitoring wells and in the Clark Fork River at the staff gage locations. This data will be used to model the mixing of the two waters and thus the potential effect of contamination of the Clark Fork River by the ground water plume. Seasonal effects will be evaluated by sampling during high flow (May-June) and low flow (August-September) periods.

Reporting

The reporting related to installation of new nested monitoring wells has been described in Section 4.4.2.4. Staff gage data, Clark Fork River flow measurements, water level measurements in wells, and results of water quality sampling will be reported in the Supplemental Site Investigation Activities Report. The ground water/surface water relationship in the vicinity of the proposed staff gages (Figure 4-1) will be discussed. An

estimate of the contribution of flow from the alluvium to the Clark Fork will be made. Geochemical modeling of mixing of ground water and surface water is discussed in Section 4.4.5.3.

4.4.5 SUBTASK 4.5 - RECEPTORS

Objectives

The objective is to identify human and aquatic receptors and estimate exposure point concentrations for various alternatives for use in the risk assessment. Human receptors will likely be ground water users. Aquatic receptors are biota in the Clark Fork in the reach potentially affected by the contaminant plume.

Previous Investigations

The RI (Woessner et al., 1984) and draft FS (HLA, 1986) identified residents of Milltown as potential ground water receptors. Other potential human receptors include users in the vicinity of the arsenic plume shown in Figure 4-1, and users further downgradient in the Valley. Residents of West Riverside, Pine Grove, and East Missoula may be affected in the future if the plume moves downgradient in the alluvium.

The Downstream Screening Study includes a door-to-door survey of residents in the vicinity of the plume shown in Figure 4-1. If receptors are identified, then wells will be sampled.

If it appears that the contaminant plume is moving downgradient in the alluvium, based on Phase I results, then additional receptors will be identified downgradient. A complete well inventory (based on Department of Natural Resources and Conservation records) is being conducted from the Milltown Dam to Hellgate Canyon, as part of the Downstream Screening Study.

Scope of Work

If receptors are identified in the vicinity of the arsenic plume, their wells will be sampled for contaminants of concern. Exposure point concentrations for human and aquatic receptors will be estimated.

Human Receptors

The exposure due to consumption of contaminated ground water will be estimated by assuming receptors in the most contaminated portion of the plume (upgradient of the Blackfoot River) and receptors downgradient in the alluvium. The intersection of I-90 and Highway 10 may be an appropriate location.

To estimate risk in the most contaminated portion of the aquifer, ground water concentrations of metals will be used. These values are available from the RI and draft FS.

To estimate risk downgradient of the sediments in the alluvial aquifer, a simple mixing cell model could be used. The maximum concentration of arsenic and other chemicals of concern will be used for the source concentration for the model. The contaminated ground water is moved down the flow path to the exposure point. Only dilution and adsorption are incorporated into this simple model. Conceptually, each iteration in the mixing cell model involves replacing the contaminated ground water in a unit volume of aquifer with clean water. The contaminant of interest is then desorbed from the aquifer media into the clean ground water, causing a corresponding decrease in concentration of the compound present in the aquifer media. Desorption from the aquifer media into the aquifer fluid is dependent upon the distribution coefficient (Kd) of the compound being modeled. It is assumed that compound adsorption/desorption reactions are reversible and follow a linear isotherm. The mixing cell model continues until ground water concentrations from desorbed aquifer media compounds are below the desired concentration value. The number of iterations required

to attain the desired ground water concentration value represents the number of pore volumes required to clean up the aquifer being modeled. An example of a mixing cell model is a proprietary code developed by Sangani and others (1988) at CDM called PVDL.

The distribution coefficient (Kd) will be obtained by conducting batch and column tests using alluvial material and highly contaminated ground water (described in Section 4.4.3.3). A geochemical equilibrium model such as MINTEQ (Felmy et al., 1984) or PHREEQE (Parkhurst et al., 1980) shall also be used to determine the major processes controlling contaminant migration. These geochemical models are thermodynamic models that are used to evaluate mineral/water conditions at various conditions of pH and Eh. Both models can be used to simulate reaction paths and have been used extensively to predict the significance of the various geochemical processes such as precipitation and sorption. Dispersion of contaminants is likely to have occurred but since actual ground water quality data will be obtained, dispersion data (e.g., dispersivity values) will not be required.

The concentration of contaminants in ground water at the exposure point will be obtained. The water level data, depth to bedrock, and vertical extent of the contaminant plume shall all be used in this analysis. A flow net will be constructed from the reservoir to the point of discharge of contaminated ground water into the Clark Fork River.

Aquatic Receptors

The potential effect of ground water contamination on the Clark Fork River will be estimated by simulating the mixture of contaminated ground water with surface water. The location of the discharge of ground water into surface water was addressed in Section 4.4.2, 4.4.3, and 4.4.4. When the location of discharge is estimated, a mass balance will be conducted for mixing of contaminated ground water and surface water. A chemical equilibrium model, MINTEQ, will be used to determine if precipitation will be important or if pure dilution is acceptable for simulation. An estimate

of the exposure point concentration will be obtained for aquatic life for the chemicals of concern.

Effect of Physical or Hydraulic Barriers on Ground Water Flow

Simple analytical solutions such as that described by Knox (1984) will be used to determine the feasibility and effect of implementing a physical or hydraulic barrier. The selected model should be capable of simulating low permeability barriers.

The use of pumping and treating can be evaluated using capture-zone type calculations which permit simulation and placement of a series of pumping wells to ensure capture of the full extent of contamination. The analytical methodology is described by Javandel and Tsang (1984) and requires estimates of aquifer properties, regional hydraulic gradients, and the depth of contamination. Additionally, hydraulic properties including transmissivities, gradients, and thickness of the reservoir sediments will be required. An estimate of the cleanup time and the number of aquifer pore volumes to be pumped can be made using the mixing cell model described previously.

Reporting

The following shall be provided in the Supplemental Site Investigation Activities Report:

- Sampling results if domestic wells are sampled in the vicinity of the plume.
- Results of the batch and column tests, geochemical modeling, and mixing cell modeling results.
- Exposure point concentrations for human or aquatic receptors, for scenarios and chemicals of concern to be determined.

4.4.6 SUBTASK 4.6 - BACKGROUND WATER QUALITY

Objective

The objective is to determine background levels for chemicals of concern in ground water, if necessary, based on the ARARs analyses.

On October 29, 1982 Montana implemented non-degradation standards for ground water. These statutes apply to ground water contaminated after the implementation date. Background is important to know, especially to compare to future contaminant movement. Stable plumes are in violation of this statute if created after the rule implementation date.

Previous Investigations

Based on the potentiometric maps provided in the RI (Woesner et al., 1984) and the draft FS (HLA, 1987), several wells were sampled upgradient of the reservoir source. Although data from the RI has been validated, the trace metal chemical analyses did not include barium, chromium, cadmium, and lead. The wells sampled by HLA (1987) included two wells (36 and 23) which are located hydraulically upgradient.

Scope of Work

At least five domestic wells located upgradient of the Milltown site will be sampled in order to determine background ground water quality, if sufficient wells to establish background quality are not available in the existing data base or if these data cannot be validated. These wells must be completed in the alluvial aquifer because no significant contamination of the bedrock aquifer is evident at the Milltown site.

Reporting

Results of sampling will be provided in the Supplemental Site Investigation Activities Report. Background values for chemicals of concern will be computed.

4.5 TASK 5.0 - SURFACE WATER INVESTIGATION

The surface water investigation involves collection of data to be utilized in evaluating remedial alternatives and addressing specific areas of concern. Various types of surface water data will be required to adequately evaluate each of the remedial action alternatives identified in Section 2.4. The Final Interim Report (CDM, 1986) identified surface water information as the primary data gap in the early draft FS (HLA, 1986). For the purpose of this report, required surface water data have been categorized into the following types of information needs:

- Characterization of the existing surface water regime in terms of streamflow and water quality
- Characterization of the physical and chemical processes controlling sediment deposition, scour, and transport through Milltown Reservoir
- Characterization of recharge/discharge relationships of surface and ground waters downstream of Milltown Reservoir
- Identification of potential receptors of contaminated surface waters
- Characterization of background surface water quality

Specific tasks necessary to provide the above information are discussed in the following sections. Further details on information needs, available data, and additional investigations required may be found in Appendix B - Data Evaluation Report.

4.5.1 SUBTASK 5.1 - CHARACTERIZATION OF THE SURFACE WATER REGIME

Objectives

Baseline streamflow and water quality data are needed to define the range of conditions expected to occur under the No Action alternative. This information then would provide a basis for comparison in evaluating each of the other alternatives in terms of expected effects to surface water.

Previous Investigations

Historical data collected by the USGS, MDHES-WQB, and others should provide a sufficient record of streamflows on the Clark Fork and Blackfoot Rivers. The USGS database, containing surface water data collected under their normal water resources monitoring program and special studies conducted in the basin; and the WQB database, containing approximately 5 years of streamflow and surface water quality data upstream and downstream of Milltown Reservoir, represent the primary sources of long-term surface water data.

In evaluating any alternative under the contingency of partial and significant failure of upstream sediment control measures, it will be necessary to have information regarding expected levels of contaminated sediment inflow to the Milltown site. Previous investigations conducted along the Upper Clark Fork River (Ingman, 1985; Rice and Ray, 1985; Moore, 1985; and USGS, 1987) present data concerning bed, bank, and floodplain sediments which can be used to generate order-of-magnitude estimates of expected sediment loads under catastrophic flood conditions.

Consideration of a 100-year flood event occurrence at the Milltown Site in evaluating alternatives will require additional information on predicted magnitude (flood hydrograph and peak flow) of the event and the corresponding 100-year floodplain to predict the location of sediments

likely to become inundated. Data collected by MPC (Curtis, 1985) in support of its FERC application will provide much of the needed information that should be obtained for the FS.

Scope of Work

Although it is unlikely that USGS data can be validated to a Level B status, confirmation of their sampling and analytical procedures will be performed by MDHES or its contractor. USGS field data logs and streamflow rating curve development notes for the gaging stations of concern will be reviewed to check for proper sampling and calculation procedures. Splits of water quality samples collected by the USGS will be obtained by MDHES or its contractor and analyzed by a CLP lab; results would then be correlated to USGS analytical results to confirm and develop the relationships between USGS and CLP results. These relationships would then be used to evaluate previous USGS data collected for use in the FS evaluations. This process has been initiated under the current monitoring effort taking place during the MPC drawdown activities at the dam (see Section 2.2). Limited confirmation of MPC data collected during reservoir drawdown is also taking place concurrently. Sampling location and parameters measured/analyzed are specified in the Sampling and Analysis Plan (SAP) (CDM, 1988).

The WQB database includes periodic split samples with USGS data at several stations upstream of Milltown Reservoir. QA/QC procedures routinely employed by the WQB are well documented. The WQB data and QA/QC procedures should be reviewed to determine the level of data validation applicable. In addition, the WQB and USGS split sample results should be reviewed to verify comparability. Based on the USGS data confirmation effort (discussed above) and this review, the usability of both the USGS and WQB databases may then be assessed.

It is suggested that concurrent monitoring also be performed in conjunction with MDHES-WQB to confirm sampling and analytical procedures. One concurrent round of sampling at the two upstream, one downstream, and one

reservoir monitoring stations with CLP analyses for comparison are needed. The SAP (CDM, 1988) should be used as a basis for preparing a SAP for this sampling.

Reporting

The results of the confirmation program will be presented in the Supplemental Site Investigation Activities Report. Sampling procedures, including QA/QC methodology/results, will be documented. Streamflow and water quality analyses by CDM, USGS, and MPC will be tabulated and correlations between the data will be presented. An evaluation of the usability of the MPC and USGS data for characterization of site surface waters, including assumptions regarding the use of previous data collected, will be presented.

4.5.2 SUBTASK 5.2 - SEDIMENT TRANSPORT CHARACTERIZATION

Objectives

To predict downstream effects on surface water quality from reservoir releases under the No Action or other alternatives, it is necessary to characterize the physical processes by which sediment transport occurs within and downstream of the reservoir. A reservoir budget analysis is necessary to define the processes of deposition and scour.

Previous Investigations

Historical data, collected primarily by the USGS and MDHES-WQB, is available. It is assumed that historical data would be representative of future conditions in terms of source materials upstream of Milltown Reservoir (a scenario in which input water quality is improved would also be considered in the FS). As discussed in Section 4.5.1.3, confirmation of USGS data is currently underway.

The remedial investigation study by Woessner et al. (1984) provides valuable information on reservoir sediments, particularly as these data have been validated. Reservoir sediment data collected by HLA (1987) for the draft FS are also available. Based on the preliminary results of a Level A/B review, most of these data will meet EPA's Level A/B quality assurance criteria. These data may not adequately characterize the sediments in areas where sediment excavation has recently taken place in conjunction with MPC's rehabilitation of the dam and power plant.

MPC studies discussed in Section 2.1 of Appendix B, Data Evaluation Report, provide useful surface water and sediment data. The sedimentation study (Curtis, 1985) may provide a sound basis to develop the reservoir budget model; confirmation of the study may be possible if the data used in the model are made available by MPC. Confirmation of MPC data collected during drawdown events is also currently taking place in conjunction with the USGS data confirmation effort.

The other sources of information discussed in Section 2.0 of Appendix B should be used to provide a more complete picture of the sediment transport processes present at Milltown. However, validation and confirmation of data are unlikely and may not be necessary providing that the final selection of an alternative is not based on such data.

Sediment Transport Model Evaluation

A review of available sediment transport models was conducted to identify potential models which may be applicable to the Milltown site. Most models are capable of simulating channel erosion and aggradation for a variety of boundary conditions along selected reaches of a stream. The primary difference between the various models is in their formulation and sediment transport functions used to predict sediment loads. The selected model must be capable of representing existing conditions and simulate various conditions expected under the remedial alternatives to be considered in the FS. The two most commonly used models are the Corps of Engineers' model

HEC-6 (Hydrologic Engineering Center, 1977) and FLUVIAL-12 (Chang, 1982). The only major differences between the two models are the capability of HEC-6 to simulate armoring of the channel bed and the option in FLUVIAL-12 to simulate bank scour. Since HEC-6 is available in the public domain, has been extensively applied and tested, and is well documented, it was selected for further evaluation.

Detailed description of the theoretical basis of model formulation for HEC-6 is provided in the referenced document (Thomas et al., 1981). HEC-6 is a one-dimensional steady state model that predicts rates of scour and deposition at selected sections along a river based on specified hydraulic conditions and sediment characteristics. Total outflow sediment load at the downstream end is also calculated. Input data required include the following:

1. Geometry of the river system represented by a series of cross-sections and distance between them. The number of cross-sections should be sufficient to establish water surface profiles.

2. Upstream and downstream boundary conditions. These are specified as corresponding inflowing sediment load for each inflowing water discharge and water stage at the downstream end. Grain-size fractions of the inflowing load must also be specified.

3. Gradation of bed material at each cross-section.

4. Manning's friction factor, n, between cross-sections. This parameter is usually based on calibration to known sediment inflow and outflow loads. Subsequent simulations then assume that n remains constant.

Data collected from previous studies and during the surface water site investigation activities should provide all the information necessary to perform the simulations. Considerable judgment must be used in conceptualizing the existing physical system and sediment transport regime. Future projections must also rely on judicious extrapolation of the inflowing sediment rating curves. The following paragraphs describe how HEC-6 can be used as a tool to provide a technical basis for evaluation of several remedial alternatives during the FS.

Limits of the study area should extend from the USGS gaging stations at Blackfoot River near Bonner and Clark Fork River at Turah Bridge upstream to the East Missoula gaging station downstream. These limits will allow use of historical flow and sediment data available at these stations. Sediment rating curves have been developed for these stations by Curtis (1985). Existing conditions can be established using normal flow conditions in the rivers and setting the stage at the Milltown Dam at normal operating level. This baseline simulation will establish all model parameters such as slope and friction factors. The following conditions can then be simulated and obtain sediment loads and locations of significant scour and deposition:

1. Reservoir operating level can be changed at the downstream end to simulate a change in operating policy.

2. Sediment removal from the reservoir can be simulated by a change in cross-section geometry across the reservoir.

3. Impacts due to channel improvements can be simulated by changing friction factors along selected reaches.

4. Impacts from flood events can be simulated by increasing the inflow discharge at the upstream end. The inflowing sediment load must be extrapolated from existing sediment rating curves.

5. Changes in upstream sediment control measures such as the Warm Springs ponds can be simulated by changing the inflowing sediment load.

Scope of Work

Surface water and sediment sampling using EPA- and State-approved sampling procedures will be required to provide validatable data to confirm data collected in previous studies and to use in development of the sediment transport model. The sampling should be conducted to measure and/or analyze the following:

- Streamflows and velocity profiles (vertical and lateral) under a range of flow conditions at the USGS gaging stations on the Clark

Fork River upstream and downstream of the reservoir, the Blackfoot upstream, and within the reservoir (at a minimum of three cross-sections, including location(s) where recent sediment excavation has occurred).

- o Water chemistry under the same range of flows and at the same locations specified above; parameters to be included are summarized in Table 4-2.

- o Grain-size distributions and total metal concentrations (Table 4-2) of the suspended sediment sampled under the same range of flows and at the same locations specified above; due to the generally low concentrations of suspended sediment under all but extremely high flow conditions, it is probably necessary to approximate the chemistry and suspended sediment grain-size using bed load samples (see next item).

- o Total and total recoverable metals concentrations (Table 4-2) and grain-size distributions of stream and reservoir bed, bank, and floodplain sediments at the locations specified above.

- o Channel and reservoir geometry (including bank areas which would be inundated under high flow conditions), channel slopes, and stream bed and bank materials/vegetation documentation (to estimate roughness coefficients).

It is important that these data (with the exception of geometry) be sampled over a range of flow conditions. If the ARARs analysis resulted in a criterion whereby the selected alternative must meet the specified ARARs under a defined flow condition (such as at any flow less than or equal to the 100-year flood), it would be inappropriate to extrapolate data from low flow samples to predict high flow consequences. If sampling is at high flows as well as low flows, impacts could be predicted with a greater degree of confidence. However, extrapolation beyond the largest flow condition monitored is not recommended to predict quantifiable impacts; such predictions are recommended to be in a qualitative form. High flow sampling should thus be performed at the onset of the event being monitored during the rising limb of the streamflow hydrograph. A SAP shall be prepared and approved by the State and EPA prior to commencement of this sampling program.

Similar information is being collected under the current monitoring effort taking place during the MPC drawdown activities at the dam (see Section

TABLE 4-2

SURFACE WATER ANALYSES

Total and Dissolved Metals	Major Anions	Others
Aluminum	Carbonate/Bicarbonate	pH (laboratory and field)
Antimony	Chloride	Specific Conductance (laboratory and field)
Arsenic	Sulfate	Total Dissolve Solids
Barium		Total Suspended Solids
Beryllium		Hardness (calculated)
Cadmium		Temperature (field)
Calcium		Dissolved Oxygen (field)
Chromium		Acidity/Alkalinity
Cobalt		Redox potential (Eh)
Copper		
(Eh)		
Iron		
Lead		
Magnesium		
Manganese		
Nickel		
Potassium		
Selenium		
Silver		
Sodium		
Thallium		
Tin		
Vanadium		
Zinc		

4.5.1.3). Historic streamflow records, the Milltown Reservoir area-capacity curve, and dam outlet and spillway rating curves will be needed to model routing of flows through the reservoir under various operating rules to be considered; the reservoir data should be obtained from MPC.

The results from the sampling program, along with the streamflow, water, quality, and sediment data available from other investigations, should be used to develop the sediment transport model for the reservoir. Unless approved otherwise by the State and EPA, the U.S. Army Corps of Engineers' HEC-6 model shall be used. Input data will be coded and model calibration runs will be performed for low, moderate, and high flow conditions to establish the baseline transport processes at the study site.

Reporting

The following information will be provided in the Supplemental Site Investigation Activities Report:

- o location map of sampling stations/cross-sections;
- o figures depicting the geometry of the sampling cross-sections;
- o sampling procedures, including QA/QC methodology/results;
- o sampling results for the surface water and sediment sampling program;
- o tabulation of input to the sediment transport model; and
- o results from the transport model calibration runs.

4.5.3 SUBTASK 5.3 - RECHARGE/DISCHARGE RELATIONSHIPS

Objectives

Upwelling of contaminated ground water into the surface flow of the lower Clark Fork becomes a surface water impact under the No Action alternative at the point (reach) of upwelling. Similarly, defining the contribution of

surface waters from the Clark Fork to the Missoula Sole Source aquifer is a key issue in assessing the impact of releases from Milltown Reservoir. River bed sediments and dissolved metal releases from the reservoir could directly impact the aquifer. The aquifer serves the largest potentially affected population downstream of the dam.

Previous Investigations

There is no information available on the relationship between ground and surface water immediately downgradient of the dam. An application for the Missoula Sole Source aquifer has recently been submitted and approved.

Scope of Work

In defining the ground water plume from Milltown Reservoir recharging to the Clark Fork downstream of the dam, streamflow and water quality sampling below the dam at various locations will be conducted to help define areal extent, and impacts to the quantity and quality of surface waters in the recharge reach. Selection of locations would be based on the findings of the ground water monitoring performed for plume definition and would be conducted under a SAP prepared for this task.

Consideration of effects on the Missoula Sole Source aquifer may be included in the FS. The recently completed application for the Sole Source aquifer will be reviewed as part of the Downstream Screening Study and evaluated for use in evaluating impacts to the aquifer. MDHES and EPA will consider the need for additional information concerning potential impacts on the Missoula aquifer based on the results of that study.

Reporting

The following information will be presented in the Supplemental Site Investigation Activities Report:

- o map showing locations of sampling activities;
- o sampling procedures, including QA/QC methodology and results; and
- o sampling results summarizing streamflow and water quality recharge/ discharge impacts.

4.5.4 SUBTASK 5.4 - SURFACE WATER RECEPTORS

Objectives

All potential receptors of contaminated surface waters stored within or released from Milltown Reservoir need to be identified for the Endangerment Assessment.

Previous Investigations

The residents of Milltown have been previously identified as receptors of ground water contaminated by Milltown Reservoir sediments (Woessner et al., 1984). Other receptors of contaminated surface waters have not been adequately defined.

Scope of Work

An inventory of surface water users within and downstream of Milltown Reservoir will be conducted by MDHES or its contractor as part of a downstream screening study. Uses could include recreation, diversion for irrigation, and recharge to alluvial aquifers providing municipal or domestic water supply. Levels of endangerment are anticipated to decrease downstream due to effects of dispersion and dilution. The downstream boundary of the inventory will therefore be the confluence of the Clark Fork and Bitterroot Rivers below Missoula.

MDFWP should be contacted to provide information on recreational use of surface waters along the Clark Fork River. The Montana Department of Natural Resources and Conservation should be contacted to obtain water

rights and irrigated land information. For lands irrigated with Clark Fork River water, soil samples of irrigated lands will be taken and analyzed for total metals concentrations.

Results

Inventory results are to be discussed in the FS report to the extent that downstream receptors are identified. Map(s) depicting the locations of surface water use, diversions, and lands irrigated will be included in a MDHES downstream screening study report. Frequency and magnitude (quantity of water diverted) will also be documented.

4.5.5 SUBTASK 5.5 - BACKGROUND SURFACE WATER QUALITY

Background levels of contaminants will be needed should the ARARs analysis result in application of the Montana non-degradation standard. For surface waters, characterization of water quality contaminant levels directly upstream of the Milltown site on the Clark Fork and Blackfoot Rivers will provide the background levels necessary (upstream Clark Fork contaminant levels may not represent "true" background due to upstream contamination). The sampling required under the characterization of sediment transport processes, along with confirmed data previously collected at these sites by the USGS and others will provide sufficient information to determine background contaminant levels. No further investigations will be required.

4.6 TASK 6.0 RESERVOIR SEDIMENTS INVESTIGATION

Objectives

A review of existing data indicates that sufficient data exists on sediment characteristics including extent of contamination, geochemical characterization, and the total volume of contaminated sediments. These data are sufficient only for completing the Feasibility Study; additional data will

be required for final design of the selected alternative if treatment alternatives are chosen. The reservoir sediments investigation should be limited to the following two activities:

- Develop an adequate understanding of the geochemical characteristics controlling arsenic and trace metal contamination to surface and ground water using existing data.
- Classify the sediments using EP-Toxicity and/or TCLP tests and identify suitable on-site or off-site disposal sites.

Scope of Work

Ongoing research studies at the University of Montana are expected to provide further information necessary to characterize the sediment geochemistry. Results from MPC's EP-Toxicity tests on sediments from 10 borings in the reservoir sediments (Hydrometrics, 1985) show metal concentrations below limits prescribed for classifying them as RCRA wastes. These data are non-validatable. Therefore, at least one boring will be obtained to confirm MPC's results. This boring should be located near the dam where the most contaminated sediments have been found (HLA, 1987) and completed through the entire thickness of fine-grained sediments. Samples should be collected at regular intervals through the full borehole depth and analyzed for total metals and for EP-Toxicity.

Reporting

The results of the analyses of the boring material shall be reported and compared to the MPC boring data.

4.7 TASK 7.0 - DATA VALIDATION

All raw data generated from project sampling tasks, field measurement activities, and previously collected data used in preparing project reports will be evaluated for use as part of the supplemental site investigation.

4.7.1 SUBTASK 7.1 - VALIDATION OF ANALYTICAL DATA

Validation of analytical data will be performed using Region VIII validation criteria. Non-validated data will not be used to define contamination problems or develop remedial measures unless stipulations as to use are specified in the Consent Order with the PRPs.

4.7.2 SUBTASK 7.2 - VALIDATION OF FIELD MEASUREMENT DATA

Validation of data obtained from field measurements will be performed by project scientists. Validity of all data will be determined by checking calibration procedures utilized in the field, and by comparing the data to previous measurements obtained at the specific site. Appreciable variations in data which cannot be explained by local changes will be assigned a lower level of validity and will be used for limited purposes. The project hydrogeologist will summarize the data obtained from field measurements and will include this information in the field activities documentation report which will be submitted to the Project Manager, State Project Officer and EPA Remedial Project Manager for review.

4.7.3 SUBTASK 7.3 - REPORTING

A technical memorandum will be submitted to MDHES summarizing the data validation results.

4.8 TASK 8.0 - PRELIMINARY SITE CHARACTERIZATION SUMMARY

This report will provide a summary of the site characterization findings based on the results of the investigations described in the discussions of Tasks 3, 4, 5, 6, and 7. The report shall be prepared and submitted to MDHES and EPA for review and approval at the close of the previously described field investigations (see Section 6.0 for Schedule). The site characterization summary will be used by MDHES to:

- o serve as a reference for evaluating the development and screening of remedial alternatives,

- o assist in the identification of applicable or relevant and appropriate requirements (ARARs), and

- o provide the Agency for Toxic Substance and Disease Registry (ATSDR) with the data necessary to conduct their health assessment.

4.9 TASK 9.0 - SUPPLEMENTAL SITE INVESTIGATION ACTIVITIES REPORT

A Supplemental Site Investigation Activities Report will be prepared which will address the Milltown Reservoir Sediments site with respect to evaluating the nature and extent of contamination on-site and the potential for transport of contaminants off-site via the identified pathways. Major sections to be included in this report are:

Introduction - This section of the report will discuss the purpose of the report and provide background information concerning site description, site history, and a summary of previous investigations.

Study Area Survey - This section will define physical characteristics of the site and include a site boundary survey and site topograhic survey. Potential sensitive receptors and transport pathways will also be identified.

Characterization of Contaminants - This section of the report will identify the source of contaminants and discuss the nature and extent of contamination as determined by the various investigations previously mentioned. Contaminant transport potential via the identified pathways will be addressed in this section. This and the preceding section are where the data interpretation is presented.

Summary and Conclusions - This section summarizes the site characterization. Data limitations are identified and recommendations for future work are outlined.

Subtask 9.1 is to prepare a draft report for review by MDHES and EPA followed by release for public comment after incorporation of comments. Subtask 9.2 is to prepare the final Supplemental Site Investigation Activities report. The report shall be submitted to MDHES and EPA for

review and approval according to the timeframe set forth in the Schedule (Section 6.0) of this Work Plan. The report shall be used by MDHES and EPA to assist in completing the ARARs analysis.

5.0 FEASIBILITY STUDY ACTIVITIES

Presented below are descriptions of the anticipated FS activities required for the Milltown Reservoir Sediments site. Activities include those that will be completed by the lead agency as well as those that may be completed by the PRPs. These tasks may be modified in the FS work plan pending discussions between MDHES, EPA, and the PRPs.

5.1 TASK 10.0 - ENDANGERMENT ASSESSMENT

The Endangerment Assessment (EA) for the Milltown Reservoir Sediments site shall consist of a baseline public health evaluation and environmental assessment prepared by MDHES or its contractor.

5.1.1 SUBTASK 10.1 - PUBLIC HEALTH EVALUATION

A baseline public health evaluation will be prepared by MDHES or its contractor and used by the PRP(s) to evaluate the degree to which the No Action alternative is protective of human health. Detailed guidance on conducting public health evaluations is provided in the Superfund Public Health Evaluation Manual (EPA, 1986) (EPA/540/1-86/060). The general objectives are to identify and characterize the following:

- Toxicity and quantity of hazardous substances present in relevant media (e.g., air, ground water, soil, surface water, sediment, and biota). The detection limits used to evaluate the quantity of hazardous substances should be based upon toxicity information and ARARs.

- Environmental fate and transport mechanisms which will influence the distribution and mobility of the contaminants within the relevant media. Mechanisms may include dissolution, volatilization, and adsorption which are directly related to physical and chemical properties as well as chemical and biological degradation processes.

- Potential exposure pathways and extent of actual or potential exposure now or in the future.

- o Potential human receptors now and in the future.
- o Quantitative risk assessment which provides numerical estimates of carcinogenic and noncarcinogenic risks associated with current and future exposure scenarios.

A baseline Public Health Evaluation (PHE) characterizes the risks associated with the No Action alternative. This information will then be used to characterize the risks associated with other remedial alternatives. For example, if carcinogenic risks associated with the no action alternative are in the 10^{-2} to 10^{-3} range, it is possible to "back calculate" the contaminant concentrations which would result in risks of 10^{-4} to 10^{-7}, EPA's generally acceptable risk range. This back calculation uses the same exposure assumptions developed in the baseline public health evaluation to determine the cleanup levels required to achieve the desired risk value. Cleanup levels required to reduce hazard indices for noncarcinogens to acceptable levels can be determined in a similar fashion.

The baseline public health evaluation can also be used to determine the degree to which a remedial alternative reduces the volume, toxicity or mobility of contaminants. For example, if a remedial alternative interrupts an exposure pathway by reducing toxicity or eliminating receptor access to contaminants, risks will also be significantly reduced.

A baseline environmental assessment is similar to a public health evaluation with the following exceptions:

- o Species of concern are identified that may be adversely affected by site contaminants including those which are threatened or endangered, ecologically important, or economically important.
- o Important habitats which may be adversely affected by site contaminants are identified and evaluated.
- o Potential risks are generally evaluated qualitatively except for risks to aquatic life which may be quantitatively evaluated on the basis of ambient water quality criteria (AWQC). In addition, action levels may be identified which are estimated to be protective of species of concern or critical habitats under site-specific conditions.

The Preliminary Endangerment Assessment (PEA) included in the Milltown Site Final Interim Report (CDM, 1986) is reprinted as Appendix A herein. This provides a basis for the public health and environmental assessment evaluation. There are several gaps, however, which need to be addressed or investigated in more detail in order to complete an adequate baseline public health evaluation. The additional data requirements include the following:

- Background concentrations of contaminants in the relevant media will be determined in order to accurately estimate the incremental risks associated specifically with the Milltown Reservoir site.

- Further discussion and/or investigation of the hydrogeologic conditions is needed to adequately characterize the contaminated aquifer.

- The exposure assessment will be expanded to include or at least address all potential exposure pathways and all potential receptors. For example, the PEA does not consider incidental ingestion of sediments by children playing along the shoreline of the reservoir or incidental ingestion of surface water due to recreational use of the river or reservoir. Bonner Junction residents represent an example of potential receptors for the exposure assessment; the residents have a sensitive population (infants and small children), exposed to airborne dust from the reservoir, and live immediately adjacent to contaminated sediments where the children play daily. When the current or potential extent of ground water contamination is clarified, additional ground water receptors may be identified.

5.1.2 SUBTASK 10.2 - ENVIRONMENTAL ASSESSMENT

Data requirements for the environmental assessment are affected by potential ARARs that will be considered. In addition, protectiveness of various remedial alternatives will be evaluated. Environmental data gaps that will be addressed or investigated include the following:

- Potential impacts to wildlife. Identification of species of concern and important wildlife habitats. For purposes of consultation on this draft Work Plan, the following species of concern are proposed:

Aquatic Species

Rainbow Trout (Game fish)
Brown Trout (Game fish)
Westslope Cutthroat Trout (Threatened)
Shorthead Sculpin (Threatened)
Tailed Frog (Threatened)
Daphnia (Indicator)

Terrestrial Wildlife/Avifauna

Peregrine Falcon (Endangered)
Bald Eagle (Endangered)
Common Loon (Threatened)
Great Blue Huron (Common in the area)
Canada Goose (introduced at the site)

- Wetland identification and mapping.

- TSS, dissolved oxygen, and dissolved/suspended heavy metals concentrations upstream and downstream of the reservoir under various flow conditions is needed to quantify the relationship between flow and water quality.

- Characterization of sensitive species in the Milltown area and determination of risks to these species associated with expected TSS and metal concentrations under alternative scenarios.

Coordination with the Montana Department of Fish Wildlife and Parks regarding these issues will be required. The EA shall be completed by MDHES following receipt of the Preliminary Site Characterization Summary (Task 8).

5.1.3 SUBTASK 10.3 - ACTION LEVELS/CLEANUP GOALS MEMORANDUM

MDHES or its contractor shall prepare a memorandum on Potential Action Levels or Cleanup Goals. According to the Superfund Amendment and Reauthorization Act (SARA), action levels (cleanup goals) selected for Superfund sites must attain applicable, relevant, and appropriate requirements (ARARs) and be protective of human health and the environment.

Potential action levels for ground water are Maximum Contaminant Levels (MCLs) for organics and inorganics as defined under ARM 16.20.101 et seq.

Potential actions levels for surface water are cleanup to Gold Book levels as defined under ARM 16.20.618. Non-degradation standards are also potential action levels for surface and ground water. Chemical-specific ARARs exist for air and water. Land disposal restrictions are the current ARARs for soils.

Protectiveness is determined based upon a site-specific risk assessment. A risk assessment estimates specific exposure routes and specific chemical intakes for identified potential current or future receptors and then characterizes the risks associated with a particular site. The EA for the Milltown Reservoir Sediments site will include a quantitative risk assessment for soils and sediments. The results will be the basis for developing protective action levels as outlined in the Superfund Public Health Evaluation Manual (EPA, 1986).

The PHE recommends focusing the development of protective action levels on the potentially carcinogenic chemicals of concern because it is the action levels for potential carcinogens that usually drive the remedial design process. At the Milltown Reservoir Sediments site, the most significant carcinogenic risks for soils and sediments are via ingestion and the only known chemical of concern that is carcinogenic via this route is arsenic. Significant noncarcinogenic risks are also possible via ingestion for lead and cadmium. Therefore, health-based action levels for arsenic in the 10^{-4} to 10^{-6} risk range and health-based action levels for lead which would reduce the Chronic Daily Intake (CDI):Reference Dose (RfD) ratio to one will be developed.

5.2 TASK 11.0 - ARARs ANALYSIS

MDHES and EPA have prepared an analysis of potential State and Federal ARARs for the Milltown Reservoir Sediments site and for the remedy selection process (Appendix D). This analysis is preliminary and does not represent an Agency position.

Under Section 121(d)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as reauthorized in 1986 under the Superfund Amendments and Reauthorization Act (SARA), remedial actions must attain a degree of cleanup which assures protection of human health and the environment. Additionally, CERCLA remedial actions that leave any hazardous substance, pollutant, or contaminant on-site must meet, upon completion of the remedial action, a level or standard of control that at least attains standards, requirements, limitations, or criteria that are "applicable or relevant and appropriate" under the circumstances of the release. These requirements, known as "ARARs," may be waived only for certain instances specified in Section 121(d)(4) of CERCLA.

An analysis of ARARs is required in order to identify potential State and Federal ARARs for evaluating remedial action alternatives for surface and ground water and sediments at the Milltown Reservoir Sediments site.

Federal ARARs are based upon the Toxic Substances Control Act; the Safe Drinking Water Act; the Clean Air Act; the Clean Water Act; the Marine Protection, Research, and Sanctuaries Act; and the Solid Waste Disposal Act. The CERCLA National Contingency Plan supplements these requirements with a list found at 50 Fed. Reg. 47948 and 47949, November 20, 1985.

In order to qualify as a State ARAR under SARA, a State requirement must meet the following requirements:

1. It must be identified to EPA in a timely manner;
2. It must be "promulgated";
3. It must be a "standard, requirement, criteria, or limitation";
4. It must be promulgated pursuant to a State environmental or facility siting law; and
5. It must be more stringent than its Federal counterpart or it may be in addition to Federal requirements.

Subparagraph 121(d)(2)(c) of CERCLA limits the applicability of State Requirements or siting laws which could effectively result in the statewide prohibition of land disposal of hazardous substances, pollutants, or contaminants unless certain conditions are met.

Subsection 121(d) of SARA requires that State and Federal substantive requirements that qualify as ARARs be complied with by remedies (in the absence of a waiver). State requirements can be waived if a State has not consistently applied or demonstrated the intent to consistently apply a requirement in similar circumstances for other remedial actions within the State (Subparagraph 121(d)(4)(E) of SARA). Federal, State, or local permits do not need to be obtained for removal or remedial actions implemented on-site (Subsection 121(e) of SARA).

The definition of "applicable" and "relevant or appropriate" requirements is derived from the National Contingency Plan, 40 CFR § 300.6 (1986) ("NCP"). However, until the new revision of the NCP is promulgated to codify Section 121 of CERCLA, the definition of the July 9, 1987, EPA memorandum on ARARs (EPA, 1987) will be used.

Applicable requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant or contaminant, remedial action, location, or other circumstance at a CERCLA site.

Relevant and appropriate requirements means cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. For example,

requirements may be relevant and appropriate if they would be "applicable" but for jurisdictional restrictions associated with the requirement.

The determination of which requirements are "relevant and appropriate" is somewhat flexible. EPA and the State may look to the type of remedial actions contemplated, the hazardous substances present, the waste characteristics, the physical characteristics of the site, and other appropriate factors. It is possible for only part of a requirement to be considered relevant and appropriate. Additionally, only substantive requirements need be followed (50 Fed. Reg. 47:946 (1985) (preamble to the NCP)).

There are three types of ARARs. The first type includes contaminant-specific requirements. These ARARs set limits on concentrations of specific hazardous substances, pollutants, and contaminants in the environment. Examples of this type of ARAR are ambient water quality criteria and drinking water standards. A second type of ARAR includes location-specific requirements which set restrictions on activities in certain types of locations. These include restrictions on activities in wetlands, floodplains, and historic sites. The third type of ARAR includes action-specific requirements. These are technology-based restrictions which are triggered by the type of action under consideration. Examples of action-specific ARARs are Resource Conservation and Recovery Act (RCRA) regulations for waste treatment, storage, and disposal.

Contaminant-specific State and Federal ARARs shall be identified in a report to be submitted by MDHES prior to the initiation of the Phase I FS (see Section 7.0 of the Work Plan schedule) in order to facilitate establishment of remedial action objectives. All potential State and Federal contaminant-specific, location-specific, and action-specific ARARs from the lists which follow and any additional such requirements identified by MDHES or EPA shall be evaluated in a preliminary screening of ARARs to be completed by MDHES in a report for use in the development of the Initial Alternative Screening Documents (IASD). MDHES may identify other Federal

and State criteria, advisories, or guidance to be considered in the evaluation of remedial alternatives. MDHES shall provide a final ARARs analysis which will be used in evaluating the remedial alternatives addressed in Phase III of the FS for compliance with State and Federal ARARs.

MDHES has developed a list of potential State and Federal ARARs. Potential State ARARs are listed and described in Table 5-1. A preliminary list of potential Federal ARARs for the Milltown Reservoir Sediments site are listed in Tables 5-2 through 5-4. For on-site actions, ARARs must be met unless requirements are waived for one of the reasons set forth in Section 121(d)(4) of CERCLA.

Overview of Institutional Controls Evaluation

A key element of the Milltown Reservoir Sediments FS shall be the evaluation of potential institutional controls as components of remedial alternatives. Institutional controls such as restrictive covenants, land use zoning restrictions, and drinking water bans shall be evaluated for the following roles:

1. To protect an engineered containment system (such as a soil cap) from disturbance.
2. As interim protection while a permanent remedy is being implemented.
3. As a sole remedy.
4. In combination with remedial alternatives to ensure protectiveness.

The reliability and effectiveness (over the long-term) of institutional controls being considered shall be evaluated according to the following criteria:

1. State or local legal authority for implementing the specific institutional control(s).

TABLE 5-1
SUMMARY OF MONTANA APPLICABLE AND/OR
RELEVANT AND APPROPRIATE REQUIREMENTS
MILLTOWN RESERVOIR SEDIMENTS SITE

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
NUISANCES ACT	MCA § 27-30-101 et. seq.	Remedies to anything injurious to health, indecent or offensive to senses	No/No	Contains no regs related to proposed alternatives
MONTANA ENVIRONMENTAL PROTECTION ACT	MCA § 75-1-101 et. seq.	State EIS law		
Model rules	ARM § 16.2.601 et. seq.	Preparation and contents of EIS	No/Yes	Substantive requirements of what information must be gathered prior to initiation of project
CLEAN AIR ACT	MCA § 75-2-101 et. seq.			
Emergency Procedures	ARM § 16.8.401 et. seq.	Requirements necessary to declare an air emergency	No/Yes	Substantive threshold which no project may exceed
General Provisions	ARM §16.8.701 et. seq.	Authority to require air monitoring and test requirements	Yes/Yes	Construction activities
Ambient Air Quality	ARM § 16.8.801 et. seq.	Defines air quality standards for various situations	Yes/Yes	Construction activities

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Visibility Impact Assessment	ARM § 16.8.1001 et. seq.	Visibility standards and analysis	Yes/Yes	Treatment alternatives, any construction activities
Permit, Const. and Operation of Air Contaminant Sources	ARM § 16.8.1101 et. seq	Permit application requirements, conditions for issuance	Yes/Yes	May be needed for treatment remedies
Open Burning	ARM § 16.8.1301 et. seq.	Open burning restrictions and permitting	Yes/Yes	May be needed for treatment remedies
Emission Standards	ARM §16.8.1401 et. seq.	Defines emission standards for various situations	Yes/Yes	Particulate matter, visible air contaminants, sulfur emissions, and odors from treatment remedies
Emission Standards for Existing Aluminum Plants	ARM §16.8.1501 et. seq.	Sets standards for fluoride visibility and monitoring	No/Yes	Visibility standards for opacity on construction activities
NUCLEAR REGULATION	MCA § 75-3-101 et. seq.	Regulation of nuclear materials		

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Stabilization of Mill Tailings Piles	ARM § 16.40.1101 et. seq.	Specifies how to stabilize tailings piles and ponds	No/Yes	Edge and side stabilization requirements of any disposal ponds or piles
WATER QUALITY	MCA § 75-5-101 et. seq.	To prevent, abate, and control pollution of waters and improve water quality		
Public Water and Sewer Plans, Cross Connections, and Drilling Water Wells	ARM § 16.20.401 et. seq.	Procedures for water and sewer systems	Yes/Yes	Replacement water supplies
Surface Water Quality Standards	ARM § 16.20.601 et. seq.	Classification and water quality standards by class	Yes/Yes	B-1 class for Clark Fork
Non-degradation of Water Quality	ARM § 16.20.701 et. seq.	Non-degradation policy	Yes/Yes	Applies to any discharge that would increase pollution in Clark Fork
Pollution Discharge Elimination System Permit	ARM § 16.20.901 et. seq.	List conditions and terms for permitting and scheduling	Yes/Yes	Compliance schedule water quality standards applicable to discharges
Groundwater Pollution Control System	ARM § 16.20.1001 et. seq.	Classification, standards, non-degradation, and permitting for groundwater	Yes/Yes	Contaminant level establishes mixing zone in some cases

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
In-Situ Mining of Uranium Control System Permit	ARM § 16.20.1101 et. seq.	Gives conditions, sampling preservation, information requirements for In-situ uranium mining	No/Yes	In-situ treatment of groundwater alternatives
PUBLIC WATER SUPPLIES, DISTRIBUTION AND TREATMENT	MCA § 75-6-101 et. seq.	Deals with water treatment and pollution of public supplies	Yes/Yes	Replacement water system
Procedural Rules	ARM § 16.20.201 et. seq.	Contaminant levels defined, sampling protocol	Yes/Yes	Defines MCLS
NATURAL STREAMBED AND LAND PRESERVATION ACT OF 1975	MCA § 75-7-101 et.seq.	Protection of streambed and adjacent property and review of projects taking place in streams	Yes/Yes	Several alternatives will impact Clark Fork river bed
WASTE AND LITTER CONTROL	MCA § 75-10-101 et. seq.	Encourages good management of solid waste through solid waste and recovery plans	Yes/Yes	Any waste from construction activities, dam retirement, or O&M alternatives
SOLID WASTE MANAGEMENT ACT	MCA § 75-10-201 et. seq.			
Motor Vehicle	ARM § 16.14.202 et. seq.	Junk vehicle law	No/No	No junk vehicle involved in any alternatives

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Refuse Disposal	ARM § 16.14.501 et. seq.	Solid waste disposal regulations	No/Yes	Some alternatives will produce refuse
HAZARDOUS WASTE MANAGEMENT ACT	MCA § 75-10-401 et. seq.	Implements RCRA on state level		
Facility Permits	ARM § 16.44.101 et. seq.	Implements state RCRA permit program	No/Yes	Any by product from treatment alternatives will need evaluation
General Provisions	ARM § 16.44.201 et. seq.	List definitions	No/No	Definitions provided in other sections
Identification and Listing of Hazardous Waste	ARM § 16.44.301 et. seq.	Defines and lists characteristics of hazardous waste	Yes/Yes	Sludges, and other treatment alternative by products
Standards Applicable to Generators of Hazardous Waste	ARM § 16.44.401 et. seq.	Manifest, packaging, and documentation requirements for hazardous waste generators	Yes/Yes	Treatment alternatives may generate wastes, moving of sediments
Standards Applicable to Transporters of Hazardous Waste	ARM § 16.44.501 et. seq.	Transporter requirement and procedures to handle spills	No/Yes	Treatment alternative refuse and sediments may be transported on site

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Hazardous Waste Treatment, Storage and Disposal Facilities	ARM § 16.44.601 et. seq.	Excludes some types of owners and operators	No/No	Exclusions do not apply to the Milltown situation
Standards for Permitted Facilities	ARM § 16.44.701 et. seq.	Sets forth purpose for establishing standards for management of hazardous waste	No/Yes	Establishes standards for the management of hazardous waste facility. However, all standards taken from 40 CFR Part 264
Closure and/or Post Closure Financial Assurance Requirements for Facilities	ARM § 16.44.801 et. seq.	Estimation of closure costs and setting up trust fund. Bonding requirements	Yes/Yes	May need to set up a maintenance trust for some remedies
Underground Storage Tanks	ARM § 16.45.101 et. seq.	Prohibition of underground tanks	No/No	No underground storage tanks planned in alternatives
MOTOR VEHICLE RECYCLING AND DISPOSAL	MCA § 75-10-501 et. seq.	Shielding on new vehicle wrecking facilities	No/No	Motor vehicles not involved in any alternatives
STATE PARTICIPATION IN CERCLA	MCA § 75-10-601 et. seq.	Authority of state to enter into Superfund Cooperative Agreements	Yes/Yes	Not related to alternatives, defines state's role

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
ENVIRONMENTAL QUALITY PROTECTION FUND ACT	MCA § 75-10-701 et. seq.	Policy to take remedial action to protect public health, welfare or the environment	Yes/Yes	Policy statement with substantive standards
JUNKYARDS	MCA § 75-15-201 et. seq.	Screening requirements of junkyards near roads	No/No	No junkyards on site
MAJOR FACILITY SITING ACT	MCA § 75-20-101 et. seq.	Prevent unreasonable depletion of natural resources and minimize adverse environmental impacts from construction of energy facilities		
Application Requirements: Alternative Siting Study and Baseline Data	ARM § 36.7.2501 et. seq.	Requirements for study of alternative site for generation facilities and transmission lines	Yes/Yes	Dam relocation alternatives, substantive requirements for all energy generation and conversion facilities
Application Requirements: Facility Description and Design	ARM § 36.7.3001 et. seq.	Operation and maintenance description requirements of proposed facility	Yes/Yes	Any alternatives involving dam improvement or relocation, requires facility to withstand destructive natural phenomena

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
SUBDIVISION AND PLOTTING ACT	MCA § 76-3-101 et. seq.	Subdivision requirements	Yes/Yes	Clark Fork channel relocation could necessitate relocation of residents
FLOOD PLAIN AND FLOOD WAY MANAGEMENT	MCA § 76-5-101 et. seq.			
Definitions	ARM § 36.15.101 et. seq.	Definitions used throughout the Act	No/No	Definitions not considered ARARs
Regulation and Enforcement	ARM § 36.15.201 et. seq.	Permitting, local regulation and enforcement rules	Yes/Yes	Some alternatives may involve use of floodplain, institutional control alternative
Floodplain and Floodway Delineations	ARM § 36.15.501 et. seq.	Hydrologic certainty for defining floodplain	Yes/Yes	100-year floodplain designation for Clark Fork
Designated Floodway Minimum Standards	ARM § 36.15.601 et. seq.	Permit requirements and standards for water diversions, flood control works, and other projects	Yes/Yes	Alternatives using diversion structures

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Flood Fringe Minimum Standards	ARM § 36.15.701 et. seq.	Standards for structures of floodplain	Yes/Yes	Applies to any structures (treatment plants) built in floodplain
NATURAL AREAS ACT OF 1974	MCA § 76-12-101 et. seq.	Establishes process for developing state's natural areas system	No/No	Procedural
FOREST RESOURCES	MCA § 76-13-101 et. seq.	Protection and conservation of forest resources; stream flow and soil erosion	No/Yes	Substantive policy statement, may have substantive standards depending on alternative
RANGELAND RESOURCES ACT	MCA § 76-14-101 et. seq.	Recognizes the importance of rangeland	No/Yes	Substantive policy statement
STRIP AND UNDERGROUND MINE SITING ACT	MCA § 82-4-101 et. seq.	Permitting procedures for new mines		
Rules and Regulations	ARM § 26.4.1801 et. seq.	Performance standards, water quality and revegetation requirements for mines	No/No	Duplicative of other sections
STRIP AND UNDERGROUND MINE RECLAMATION ACT	MCA § 82-4-201 et. seq.	Reclamation Act for coal and uranium mines		

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Definitions and Strip Mine Permit Application Requirements	ARM § 26.4.301 et. seq.	Definitions and baseline information requirements, prime farm lands	No/Yes	Wildlife and soil requirements and use of cover crop may be relevant for exposed soil and sediment
Backfilling and Grading Requirements	ARM § 26.4.501 et. seq.	Provisions for cut and fill terraces, backgrading, waste disposal, soil cover	No/Yes	Construction activities
Transportation Facilities, Use of Explosives and Hydrology	ARM § 26.4.601 et. seq.	Provisions for embankment slopes, drainages, sealing of drill holes, sedimentation ponds, acid/toxic spoils, groundwater and monitoring	No/Yes	Acid/toxic sediments may be encountered, limitation on pH of water discharges given presence of iron
Topsoiling, Revegetation and Protection of Wildlife and Air Resources	ARM § 26.4.701 et. seq.	Reclamation standards for topsoiling, revegetation and wildlife/air resources protection	No/Yes	Reclamation of areas disturbed in construction activities
Alluvial Valley Floors, Prime Farm Lands, Alternative Reclamation, and Auger Mining	ARM § 26.4.801 et. seq.	Monitoring requirements, protection of alluvial valley floors and farming	No/Yes	Topsoil depth, monitoring, and alternate reclamation requirements may be relevant

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Underground Coal and Uranium Mining	ARM § 26.4.901 et. seq.	Use of orders and civil penalties, abandoned mine program	No/No	Procedural
Special Department Procedures and Programs	ARM § 26.4.1201 et. seq.	Use of orders and civil penalties, abandoned mine program	No/Yes	Substantive prohibition on causing any imminent danger or harm, also specific objectives of reclamation
HARD ROCK MINING ACT	MCA § 82-4-301 et. seq.			
Rules and Regulations	ARM § 26.4.101 et. seq.	Revegetation and reclamation requirements. Abandon mines and pits	No/Yes	Reclamation of areas disturbed by construction of an alternative
OPEN CUT MINING ACT	MCA § 82-4-401 et. seq.			
Rules and Regulations	ARM § 26.4.201 et. seq.	Applicable to sand, gravel, bentonite, clay, scoria, and phosphate rock mining. Described reclamation requirements for vegetation, soils, slopes, and contouring	No/Yes	Reclamation of areas disturbed by construction of an alternative

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
WATER RESOURCES	MCA § 85-1-101 et. seq.	Describes Dept. Natural Resources's responsibilities, sets up state Water Development Bureau, bonding authority for water projects and hydropower authorization	Yes/Yes	Substantive policy standards and requirements having to do with state waters
SURFACE AND GROUND WATER	MCA § 85-2-101 et. seq.	State's water right permitting and adjudication law	Yes/Yes	Any replacement water supply wells may need to meet substantive requirements
DAM SAFETY ACT	MCA § 85-15-101 et. seq.	Codes dealing with repair and safety of dam	Yes/Yes	Dam improvement and replacement alternatives, PMF standard, rules will be promulgated fall of 1988
NATURAL RESOURCES INFORMATION SYSTEM	MCA § 90-15-101 et. seq.	Establishes a natural resource information system	No/No	Procedural
FISH AND WILDLIFE, ORGANIZATION AND OPERATION	MCA § 87-1-101 et. seq.			

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Resource Statements	ARM § 12.5.101 et. seq.	Policy of orderly and planned development of any natural resource so long as reclamation takes place	Yes/Yes	Policy statement that fish and wildlife is a beneficial use of water
Rearing Fish	ARM § 12.7.401 et. seq.	Persons placing dams in a stream must put in fish ladder	Yes/Yes	Alternatives involving environmental mitigation
Fish Planting Policies	ARM § 12.7.601 et. seq.	Requirements for planting fish	Yes/Yes	Alternatives involving environmental mitigation
Department of Commercial Fish Planting	ARM § 12.7.701 et. seq.	List approved species for planting	Yes/Yes	Alternatives involving environmental mitigation
NONGAME AND ENDANGERED SPECIES CONSERVATION ACT	MCA § 87-5-101 et. seq.	Endangered species list and regulations		
Endangered Species	ARM § 12.5.101 et. seq.	Endangered species list	Yes/Yes	Should check list to see if any endangered species along Clark Fork

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Public Use Regulations	ARM § 12.8.201 et. seq.	Standards governing all land controlled by Fish, Wildlife Parks including vehicles, fires, property disturbance, waste disposal	No/Yes	Some items may be relevant to remedial alternatives
ANTIQUITIES	MCA § 22-3-101 et. seq.			
Cultural Resources	ARM § 12.8.501 et. seq.	Procedures and requirements for identification, evaluation, and mitigation of impacts on heritage properties. Also paleontological remains	Yes/Yes	All alternatives except no action will impact a potential historic site
OCCUPATIONAL HEALTH ACT	MCA § 50-70-101 et. seq.	Protection of human health and safety in the work place		
Noise and Air Contaminants	ARM § 16.42.101 et. seq.	Noise and air contaminant levels in the work place	Yes/Yes	Worker safety will need to be addressed for all alternatives
WELL WATER CONTRACTORS	MCA § 37-43-101 et. seq.			

TABLE 5-1 (continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Construction Standards	ARM § 36.21.601 et. seq.	Construction standards for water wells	Yes/Yes	Monitoring wells replacement water supply well

TABLE 5-2

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
CONTAMINANT-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Safe Drinking Water Act	42 USC § 300g			
National Primary Drinking Water Standards	40 CFR Part 141	Establishes health-based standards for public water systems (maximum contaminant levels)	Yes/Yes	The MCLs for inorganic contaminants are applicable. The Milltown water supply is a public water system.
National Secondary Drinking Water Standards	40 CFR Part 143	Establishes welfare-based standards for public water systems (secondary maximum contaminant levels)	No/Yes	Secondary MCLs for inorganic contaminants are relevant and appropriate.
Maximum Contaminant Level Goals	Pub. L. No. 99-330, 100 Stat. 642 (1986)	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety	No/No	Proposed MCLGs for inorganic contaminants are found in the Nov. 13, 1985 Federal Register. These should be treated as "other criteria, advisories, and guidance" unless there are special reasons for requiring compliance with MCLGs.
Sole Source Aquifer Requirements			Yes/Yes	
Clean Water Act	33 USC §§ 1251-1376			
Water Quality Criteria	40 CFR Part 131 Quality Criteria for Water	Sets criteria for water quality based on toxicity to aquatic organisms and human health	No/Yes	AWQCs for both human health and aquatic life for inorganic contaminants are relevant and appropriate.

TABLE 5-2 (cont.)

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
CONTAMINANT-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Dredge or Fill Requirements (Section 404)	40 CFR Parts 230, 231	Regulates discharge of dredged or fill material into navigable waters	Yes/Yes	
Natural Pretreatment Standards	40 CFR Part 403	Sets standards to control pollutants which pass through or interfere with treatment processes in publically owned treatment works (POTW)	Yes/Yes	If the atlernatives developed include discharge to a POTW.
Clean Air Act	42 USC §§ 7401-7642			
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes standards for ambient air quality to protect public health and welfare (including standards for particulate matter and lead)	Yes/Yes	Federal standards are applicable, but implemented through state air programs.
New Source Performance Standards	40 CFR Part 60			
National emission standards for hazardous air pollutants	40 CFR Part 61	Sets emission standards for designated hazardous pollutants, including mercury, beryllium, and inorganic arsenic.	No/Yes	Potentially relevant and appropriate for emissions containing arsenic from a treatment system.

TABLE 5-3

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
LOCATION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Archaeological and Historic Preservation Act	16 USC § 469 40 CFR § 6.301(c)	Establishes procedures to provide for preservation of historical and archaeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program	Yes/Yes	If portions of the site are in National Historic Preservation Areas. Specific determination of the Milltown Dam is required.
National Historic Preservation Act	16 USC § 470 40 CFR § 6.301(b) 36 CFR Part 800	Requires Federal agencies to take into account the effect of any Federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for Register of Historic Places	Yes/Yes	If the remedy would affect any district, site, building, structure, or object listed on or eligible for the National Register.
Historic Sites, Buildings and Antiquities Act	16 USC §§ 461-467 40 CFR § 6.301(a)	Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	Yes/Yes	If portions of the site are in National Historic Preservation Areas.
Fish and Wildlife Coordination Act	16 USC §§ 661-666 40 CFR § 6.302(g)	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources	Yes/Yes	Alternatives developed may modify streams.

TABLE 5-3 (cont.)

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
LOCATION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Endangered Species Act	16 USC §§ 1531-1543 50 CFR Parts 17, 402 40 CFR § 6.302(h)	Requires that Federal agencies insure that any action authorized, funded, or carried by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat	Yes/Yes	If endangered species are identified on-site.
Executive Order on Floodplains Management	Exec. Order No. 11,988 40 CFR § 6.302(b) & Appendix A 40 CFR Parts 230 and 231 CWA §404	Requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the maximum extent possible, the adverse impacts associated with direct and indirect development of a floodplain	Yes/Yes	If an alternative developed would affect a floodplain.
Executive Order on Protection of Wetlands	Exec. Order No. 11,990 40 CFR § 6.302(a) & Appendix A	Requires Federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists	Yes/Yes	If an alternative developed would affect a wetland.
Wild and Scenic Rivers Act	16 USC §§ 1271-1287 40 CFR K 6.302(e) 36 CFR § 297	Establishes requirements applicable to water resource projects affecting wild, scenic, or recreational rivers within or studies for inclusion in the National Wild and Scenic Rivers System	No/No	The Clark Fork River is not classified at a Wild and Scenic River.

TABLE 5-3 (cont.)

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
LOCATION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
RCRA	40 CFR 264.18(b)	Regulates placement of a RCRA TSD facility within the 100-year floodplain.	Yes/Yes	
Rivers and Harbors Act of 1899	33 USC § 403			
Section 10 Permit	33 CFR Parts 320-330	Requires permit for structures or work in or affecting navigable waters.	Yes/Yes	A permit is not required for on-site CERCLA response actions, but substantive requirements would be met if an alternative developed would involve structures or work in or affecting navigable waters.

TABLE 5-4

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
ACTION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Solid Waste Disposal Act ("SWDA")	42 USC §§ 6901-6987			
Guidelines for the Thermal Processing of Solid Wastes	40 CFR Part 240	Prescribes guidelines for thermal processing of municipal-type solid wastes	No/No	The waste at Milltown is considered solid waste but is not municipal waste.
Guidelines for the Land Disposal of Solid Wastes	40 CFR Part 241	Establishes requirements and procedures for land disposal of solid wastes	Yes/Yes	
Guidelines for the Storage and Collection of Residential, Commercial, and Institutional Solid Waste	40 CFR Part 243	Establishes guidelines for collection of residential, commercial, and institutional solid wastes	Yes/Yes	The waste at Milltown is considered solid waste.
Source Separation for Materials Recovery Guidelines	40 CFR Part 246	Establishes requirements and recommended procedures for source separation by Federal agencies of residential, commercial, and institutional solid wastes	No/Yes	
Guidelines for Development and Implementation of State Solid Waste Management Plans	40 CFR Part 256	Establishes requirements for Federal approval of State programs to regulate open dumps	No/No	

TABLE 5-4 (cont.)

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
ACTION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment	Yes/Yes	The current Subtitle D program is principally aimed at municipal and industrial solid waste and does not fully address mining waste concerns. Subtitle D is currently being revised to address mining wastes. However, the criteria still will be used in considering disposal sites.
Hazardous Waste Management System: General	40 CFR Part 260	Establishes definitions as well as procedures and criteria for modification or revocation of any provision in 40 CFR Parts 260-265	No/No	Creates no substantive cleanup requirements.
Identification and Listing of Hazardous Waste	40 CFR Part 261	Defines those solid wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 270, 271, 124	No/No	Creates no substantive cleanup requirements. Under 40 CFR § 261.4(b)(7), solid waste from the extraction, beneficiation, and processing of ores and minerals is not hazardous waste. However, under CERCLA, SWDA requirements may be relevant and appropriate under the circumstances of the release at the site. In this chart, any solid wastes which pose a threat to public health or welfare or the environment are termed "hazardous materials."

TABLE 5-4 (cont.)

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
ACTION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Establishes standards for generators of hazardous waste	No/Yes	Relevant and appropriate if sediment disposal alternative developed would involve off-site treansportation of hazardous materials.
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Establishes standards which apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR Part 262	No/Yes	Relevant and appropriate if sediment disposal alternative developed would involve off-site transportation of hazardous materials.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR Part 264	Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste	No/Yes	Certain past Part 264 standards may be relevant and appropriate to the final or interim disposal of hazardous materials.
Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR Part 265	Establishes minimum national standards that define the acceptable management of hazardous waste during the period of interim status and until certification of final closure, or if the facility is subject to post-closure, responsibilities are fulfilled	No/No	Remedies should be consistent with the more stringent Part 264 standards as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public welfare and the environment.

TABLE 5-4 (cont.)

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
ACTION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	40 CFR Part 266	Establishes requirements which apply to recyclable materials that are reclaimed to recover economically significant amounts of precious metals, including gold and silver	No/Yes	Does not establish additional cleanup requirements. However, does not permit stockpiling solely for future resource recovery.
Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities	40 CFR Part 267	Establishes minimum national standards that define acceptable management of hazardous waste for new land disposal facilities	No/No	Remedies should be consistent with the more stringent Part 264 standards as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and welfare and the environment.
Land Disposal Criteria	40 CFR Part 268		No/Yes	Requirements for landfill disposal of sediments may be relevant and appropriate.
Hazardous Waste Permit Program	40 CFR Part 270	Establishes provisions covering basic EPA permitting requirements	No/No	A permit is not required for on-site CERCLA response actions. Substantive requirements are addressed in 40 CFR Part 264.
Underground Storage Tanks	40 CFR Part 280	Establishes regulations related to underground storage tanks	No/No	Use of underground storage tanks is not being considered.

TABLE 5-4 (cont.)

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
ACTION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Clean Water Act	33 USC §§ 1251-1376			
Dredge or Fill Requirements (Section 404)	40 CFR Parts 230, 231 33 CFR Part 323	Regulates discharge of dredged or fill material into the waters of the United States	Yes/Yes	A permit is not required for on-site CERCLA response actions, but substantive requirements would be met if an alternative developed would involve discharge of dredged or fill material into the waters of the United States.
National Pollutant Discharge Elimination System	40 CFR Parts 122, 125	Requires permits for the discharge of pollutants from any point source into waters of the United States	Yes/Yes	A permit is not required for on-site CERCLA response actions, but the substantive requirements apply.
Effluent Limitations	40 CFR Part 440	Sets technology-based effluent limitations for point source discharges in the Ore Mining and Dressing Point Source Category	Yes/Yes	Less stringent than AWQC.
National Pretreatment Standards	40 CFR Part 403	Sets standards to control pollutants which pass through or interfere with treatment processes in publicly owned treatment works or which may contaminate sewage sludge.	Yes/Yes	If the alternatives developed include discharge to a publicly owned treatment works.
RCRA	40 CFR 264.71-72	Regulates transport of treated material to POTW by track, rail or pipe.	No/Yes	

TABLE 5-4 (cont.)

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE
ACTION-SPECIFIC
FEDERAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS
MILLTOWN RESERVOIR SEDIMENT SITE, MT

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Surface Mining Control and Reclamation Act	30 USC §§ 1201-1328	Establishes provisions designed to protect the environment from the effects of surface coal mining operations and, to a lesser extent, non-coal mining	No/Yes	
Underground Injection Control Act	40 CFR 144 & 146	Regulates injection of hazardous waste or treated ground water	No/Yes	CERCLA injection of treated ground water is allowed. Other requirements may be relevant and appropriate such as injection pressures, etc.
Occupational Safety and Health Act	29 USC §§ 651-678	Regulates worker health and safety	Yes/Yes	Under 49 CFR § 300.38, requirements of this Act apply to all response activities under the NCP.
Federal Mine Safety and Health Act	30 USC §§ 801-962	Regulates working conditions in underground mines to assure safety and health of workers.	No/Yes	Under 40 CFR § 300.38, all applicable health and safety requirements apply to all response activities under the NCP.
D.O.T. Hazardous Material Transportation Regulations	49 CFR Parts 107, 171-177	Regulates transportation of hazardous materials	Yes/Yes	ARAR only if an alternative developed would involve transportation of hazardous materials.

2. Enforceability of the institutional control(s).

3. Availability of resources for the State or local government charged with responsibility of implementing the control(s).

4. Commitment of State of local government to enact, implement, and/or enforce the control.

5. Potential for change in the control(s) through variances, amendments, inter-party agreements, etc.

5.3 TASK 12.0 - REMEDIAL ALTERNATIVES SCREENING

The Feasibility Study process provides a structured means to identify and evaluate remedial alternatives which remedy the human health and/or environmental risks. The FS will be conducted in accordance with the requirements of CERCLA; the National Contingency Plan (NCP) (50 Fed. Reg. 47912, November 20, 1985); Draft "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," March 1988 (EPA, 1988); "CERCLA Compliance with Other Laws Manual," November 25, 1987 draft (OSWER Directive 9234.1-01); "Interim Guidance on Superfund Selection of Remedy" (OSWER Directive 9355.9-10), J. Winston Porter, December 24, 1986; and "Additional Interim Guidance for FY '87 Records of Decision," J. Winston Porter, July 24, 1987. The FS shall also be conducted in accordance with forthcoming guidance or statutory promulgations, such as the revised NCP.

The FS will be performed in three phases as set forth in the following discussion. The three subphases of the FS are:

- Phase I: Identification and development of remedial action alternatives (Task 12).
- Phase II: Refinement of the alternatives and the selection of alternatives for detailed analysis (Task 12).
- Phase III: Detailed analysis of the remedial alternatives (Task 13).

Under Phase I, remedial action objectives are established which will be addressed by the proposed remedial action alternatives. These objectives are defined in terms of a contaminant of concern in a specific medium, exposure route and receptor, and an acceptable contaminant level for the exposure route. Acceptable contaminant levels are determined by the Endangerment Assessment and Applicable or Relevant and Appropriate Requirements (ARARs). A preliminary identification of potential State and Federal ARARs for the Milltown Reservoir Sediment site is provided in Tables 5-1 through 5-4. General response actions are then developed to satisfy the remedial action objectives. Some examples of possible response actions include treatment, containment, and disposal. At a minimum, the response actions set forth in 40 CFR Section 300.70 will be considered as well as one in each of the five categories in 40 CFR Section 300.68(f)(1).

The next step of Phase I involves the identification and preliminary screening of technology types and their representative process options. Several technology types may exist for a given response action, with each type encompassing various process options. For example, the general response actions under the general technology of water treatment, consist of physical, biological, chemical, and thermal technology types. For a tailings medium, physical treatment processes could include fixation. At this stage of the screening, technology types are evaluated based solely on their technical implementability. The process options associated with the technology types determined to be implementable are then evaluated and screened in terms of effectiveness, implementability, and cost. The emphasis of the evaluation is placed on effectiveness in protecting human health and the environment.

At this point in Phase I, remedial action objectives will have been established, potential response actions to satisfy the objectives identified, and technology types/process options developed for each response action. All of the evaluation criteria utilized during Phase I are applied to medium specific technologies and not to the entire site. The final step in Phase I is to assemble remedial action alternatives which

address the conditions of the site as a whole, by combining the various response actions and technology types-process options. The alternatives should span the required degree of treatment range described above and include containment technologies.

Institutional controls such as restrictive covenants and land use controls shall be considered in the development of remedial alternatives. Institutional controls shall be evaluated in support of an engineered containment system, as interim protection while a permanent remedy is being implemented, and as a sole remedy. An evaluation of the legal authorities of State and local government to implement and enforce these categories of institutional controls will be prepared and submitted for the evaluation of the State Attorney General and local government counsel for their review and comment. The results of the PRP, State, and local government evaluations shall be included in the Initial Alternative Screening Document submitted to MDHES. The overall results of the Phase I analysis will be set forth in the Initial Alternatives Screening Document required at the conclusion of the Phase II FS.

The purpose of Phase II is to select remedial action alternatives to be analyzed in greater detail from those developed under Phase I. This is accomplished by refining the Phase I alternatives. The refinement of alternatives is necessary to provide sufficient information from which to base the subsequent evaluation. This step involves quantifying the contaminated media to be remediated, that is, determining the volume of ground water to be treated or the area to be contained. This allows the technology process options to be better defined in terms of size, treatment flow rates, space requirements, and permit requirements.

The remedial alternatives are then evaluated on the criteria of effectiveness, implementability, and cost. Effectiveness is judged in terms of protecting human health and the environment. The technical feasibility of constructing and operating a specific alternative and the administrative ability to gain institutional approval from the necessary agencies are the

two components of implementability. Cost evaluation entails the estimation of capital costs and operation and maintenance costs for the remedial alternatives.

Screening of the alternatives then occurs by comparing the results of the evaluations. Remedial alternatives with the most favorable overall evaluations are retained to undergo detailed analysis. The screening procedure should attempt to maintain representatives from the full range of treatment and containment technologies developed in Phase I.

Innovative technologies should be carried through if there is reasonable belief that they offer potential for better treatment performance or implementability, few or lesser adverse impacts than other approaches, or lower cost than demonstrated technologies. A clear rationale for eliminating a treatment methodology from further consideration will be provided in the IASD. Bench- and pilot-scale treatability test needs shall be identified for remaining technologies, along with additional field data requirements in the IASD.

A key step in Phase II of the FS is the identification and verification of action-specific Federal and State ARARs. Potential ARARs for the Milltown Reservoir Sediment site are listed in Section 5.2. MDHES shall provide an initial screening of potential ARARs prior to completion of Phases I and II of the FS and preparation and submittal of the IASD. The MDHES ARARs analysis will be incorporated into the Phase II evaluation and the IASD report.

5.4 TASK 13.0 - REMEDIAL ALTERNATIVES EVALUATION

After site characterization and treatability study results are available, Phase III of the FS process is conducted. Phase III provides the basis for determining which remedy to implement. It consists of the same steps as those taken in Phase II, but because fewer remedial alternatives remain to be evaluated, the analysis is undertaken in greater detail. Again,

alternatives are further defined with respect to the quantities of contaminated media to be addressed and to the technology performance requirements. Any available information concerning the site or the process options is considered at this time. Modifications to process options first identified in Phase I are made if necessary.

Institutional controls which survive the initial screening shall be further evaluated. Upon MDHES approval of the IASD, MDHES shall contact the State or local governmental body charged with implementing and enforcing the institutional control(s) concerning the following issues:

1. Availability of resources to implement and enforce the institutional control(s).

2. Commitment to enact, implement, and/or enforce the control(s) and any associated timeframes.

MDHES will provide the results of its contacts with State and local government along with instructions on how to incorporate them into the draft FS report. The draft FS report will address the following criteria for each institutional control being considered:

1. Legal authority

2. Enforceability by Federal, State, or local government

3. Availability State or local government resources to implement

4. Commitment of State or local government to implement

5. Potential for change through variance, amendment, etc.

The remedial alternatives will be assessed in detail with respect to effectiveness, implementability and cost per guidance criteria specified in OSWER Directive 9355.0-21, "Criteria for Evaluating Alternatives" and the CERCLA RI/FS Guidance (EPA, 1988). The assessment of effectiveness of an alternative focuses on protection of human health and the environment. Two factors are used to evaluate alternatives relative to each other:

protectiveness and reduction of toxicity, mobility, or volume through treatment. Protectiveness is intended to address both short- and long-term conditions and includes the following components:

- o Compliance with chemical-specific and location-specific ARARs.
- o Compliance with appropriate criteria, advisories, and guidances.
- o Ability to protect the community during remedial actions.
- o Ability to protect workers during remedial actions.
- o Length of time until protection is achieved.
- o Magnitude of residual or untreated waste and associated risks after the remedy is complete.
- o Long-term reliability of the remedy after all remedial activities are complete.
- o Ability to prevent future exposure to residual contaminants.
- o Potential need for replacement of processes designed for use indefinitely or for long-term containment systems.

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete; it also includes operation, maintenance, replacement, and monitoring of technical components of an alternative, if required, into the future after the remedial action is complete. Components of technical feasibility include:

- o Short-term reliability of process technologies used during the remedial action.
- o Compliance with action-specific ARARs.
- o The ability to monitor the effectiveness of the remedy.
- o The ability to perform operation and maintenance functions on processes designed for use indefinitely and on long-term containment systems for as long as necessary.

Administrative feasibility during screening of alternatives is measured primarily by the ability to obtain approvals from other agencies. Other components, such as the likelihood of favorable community response, are not considered until the detailed analysis. For screening of alternatives, components of administrative feasibility include:

- The ability to obtain approvals from other agencies.
- The ability to comply with location-specific ARARs (i.e., preservation of historic sites).

Availability of technology and resources during screening of alternatives is measured primarily by the availability of treatment, storage, and disposal services and capacity. Other needs for specific equipment and technical specialists are considered further in the detailed analysis.

Finally, an evaluation of cost is performed. Cost estimates should have an accuracy of +50 percent to -30 percent. Cost estimates are calculated for both capital and operations and maintenance costs. Capital costs include construction, land and site development, buildings and services, and relocation of affected population. Operations and maintenance costs include operating labor, maintenance material and labor, auxiliary material and energy, purchased services, disposal, and periodic monitoring. The final step is performance of a present worth analysis based on an 8 percent discount rate and minimal design life of 30 years.

In evaluating alternatives, a phased approach to implementation of remedial actions will be considered based upon implementation of remedial actions on upstream Clark Fork sites. For instance, it may be desirable to implement institutional controls now and phase in remedial action when upstream cleanup goals are met. This decision should be based on an analysis of the likelihood of upstream remedial action implementation. This decision should evaluate the following scenarios at a minimum:

- o assume remedial actions at Warm Spring Ponds and other operable units of the Silver Bow Creek/Butte and Anaconda Smelter NPL Sites will be implemented

- o upstream remedial actions will be designed for half the probable maximum flood.

- o upstream remedial actions will be based on non-degradation standards.

5.5 TASK 14.0 - FEASIBILITY STUDY REPORTS

SUBTASK 14.1 - DRAFT FEASIBILITY STUDY REPORT

A draft FS report will be prepared at the completion of both Phase I and Phase II of the FS documenting the objectives, evaluations, and results of the Feasibility Study. The draft report will contain the following items:

- o Remedial response objectives.

- o ARARs analysis.

- o Description of potential remedial technologies and formation of alternatives.

- o Description of screening methodology.

- o Results of screening evaluations.

- o Description of alternative evaluation process.

- o Results of alternative evaluation (technical, environmental, human health, institutional, cost).

- o Summary and comparison of alternatives.

This report will be reviewed by MDHES and EPA and then released for public review and comment after incorporation of comments.

In addition, an Initial Alternatives Screening Document (IASD) will be prepared at the completion of subphase I associated with the initial evaluation of remedial alternatives. The IASD will document the first phases of the FS process for the Milltown Reservoir Sediments site FS.

SUBTASK 14.2 - FINAL FEASIBILITY STUDY REPORT

Revisions resulting from the public review and comment process will be incorporated. The final report will be submitted for Agency and public (library) distribution.

6.0 SCHEDULE

The following preliminary schedule identifies anticipated deliverables, and the party responsible for the deliverable. Due dates are provided for PRP(s) deliverables. Reference to Task numbers corresponds to the description of the task in the preceding text. Several dates are expressed as within a number of days of the effective date of the order (EDOA). All timeframes are expressed in calendar days and assume MDHES will have the enforcement lead. If EPA retains the enforcement lead, the schedule will be revised accordingly.

Deliverable	Responsibility	Due Date
1. Inventory of potentially protected resources (Task 4):		
Historical/Architectural Eligibility Report	PRP(s)	30 days EDOA
Determination of Effects	MDHES/SHPO	Prior to field sampling
Endangered Species Report	PRP(s)	90 days EDOA
Wetlands Report	PRP(s)	90 days EDOA
Floodplains Report	PRP(s)	90 days EDOA
2. Sampling and Analysis Plans	PRP(s)	60 days EDOA
Ground Water Inv. (Task 5)		
Surface Water Inv. (Task 6)		
Sediments Inv. (Task 7)		
Review and Comment	MDHES/EPA	
Revised SAPs	PRP(s)	W/in 15 days of receipt of EPA comments
3. Initiate Supplemental Site Investigation Tasks	PRP(s)	Upon approval
4. Data Validation Report (Task 7)	PRP(s)	45 days EDOA

5.	Initiate Phase I FS Tasks	PRP(s)	ASAP
	Institutional Controls		
	Legal Opinion	PRP(s)	21 days EDOA
	Att. General Opinion	MDHES/EPA	
	Alternatives Scoping	PRP(s)	
	Tr. Technologies Scoping	PRP(s)	
	Scoping Meeting Summary	PRP(s)/MDHES/EPA	30 days EDOA
6.	Potential State/Federal ARARs	MDHES/EPA	Prior to IASD
7.	IASD Report	PRP(s)	30 days from receipt of ARARs
	Alternatives Screening		
	Tr. Technology Screening		
	Inst. Controls Screening		
	Preliminary Draft		
	EPA Comment		
	Final Draft		
	EPA Approval		
8.	Institutional Controls		
	Contact State and Local Governments	MDHES/EPA	Prior to preliminary Draft RI/FS
	Determine Procedures to Implement	MDHES/EPA	Prior to preliminary Draft RI/FS
9.	Identify add. Data Needs	MDHES/EPA	
	Additional Scope of Work		
	Phase II RI, Phase III FS	MDHES/EPA	As necessary
	Sampling and Analysis Plan	PRP(s)	W/in 15 days of receipt of MDHES/EPA scope of work
	Review and Comment	MDHES/EPA	
	Final SAP	PRP(s)	W/in 15 days of receipt of MDHES/EPA comments
10.	Preliminary Site Summary	PRP(s)	Determined by SAP schedules
	Compile all Data		
	Id. Final Alternatives		
	Preliminary Rept. Tr. Tech.		
	Document Pathways/Exposure Potential		

11. Endangerment Assessment/PHEA	MDHES/EPA	Prior to preliminary draft SSI/FS
12. Final ARARs	MDHES/EPA	Prior to preliminary draft SSI/FS
13. Final Institutional Controls	MDHES/EPA	Prior to preliminary draft SSI/FS
14. Preliminary Draft SSI/FS	PRP(s)	W/in 30 days of receipt of ARARS, EA/PHEA, and Instit. Controls
15. Review and Comment	MDHES/EPA	
16. Final Draft SSI/FS	PRP(s)	W/in 30 days of receipt of MDHES/EPA comments
17. Proposed Plan	MDHES/EPA	Minimum of 30 days
18. Public Comment		Minimum of 21 days
19. Comment	MDHES/EPA	
20. Draft Final RI/FS	PRP(s)	W/in 15 days of receipt of MDHES/EPA comments
21. Review and Comment	MDHES/EPA	
22. Final RI/FS	PRP(s)	W/in 15 days of receipt of MDHES/EPA comments
23. Approval	MDHES/EPA	
24. Responsiveness Summary	MDHES/EPA	
25. Record of Decision	EPA	

7.0 REFERENCES

Aamodt, P.L. 1978. Uranium Hydrogeochemical and Stream Sediment Pilot Study of the Boulder Batholith, Montana. Los Alamos Scientific Laboratory Informal Report LA-7176-MS.

Andrews, E.D. 1986. Longitudinal Dispersion of Trace Metals in the Clark Fork River, Montana. Chapter 11 in Chemical Quality of Water and the Hydrologic Cycle, by Averett, Robert C. and McKnight, Diane M. Lewis Publishers, Inc. 1987.

Braxton, David E. 1980. Uranium Hydrogeochemical and Stream Sediment Reconnaissance Data Release for the Butte NTMS Quadrangle, Montana, Including Concentrations of Forty-two Additional Elements. U.S. Department of Energy. Informal Report LA-7668-MS. May.

Brook, E. and J. Moore. Undated. Distribution and Particle Size Control of Metals in Bed Sediment from the Clark Fork River, Montana, USA. Submitted to Water Research.

Burton, G., A. Drotar, J. Lazorchak, and L. Bahls. 1987. Relationship of Microbial Activity and Ceriodaphnia Responses to Mining Impacts on the Clark Fork River, Montana. Archives of Environmental Contamination and Toxicology 16, 523-530.

Camp Dresser & McKee Inc. (CDM). 1986. Final Interim Report, Milltown Site, Milltown, Montana. October 30.

_____. 1988. Sampling and Analysis Plan, Milltown Reservoir Sediments Site, June 26.

Canton, Stephen P. 1985. Chadwick and Associates, personal communication, April 19, 1985 to S.R. Black.

CH2M Hill. 1983. Draft Remedial Action Master Plan, Milltown, Montana. EPA document number 01.8V23.

_____. 1988. Agency Review Draft, Warm Springs Ponds Feasibility Study, August 30, 1988. Prepared for Montana Department of Health and Environmental Sciences. Helena, Montana.

Chang, H.H. 1982. Mathematical Model for Erodible Channels, ASCE J. Hydraulic Engineering, 108 (HY5), pp. 678-689.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Dept. Interior, Fish and Wildlife Service, FWS/OBS 79/31. 103 pp.

Curtis, W.L., 1984. Milltown Hydroelectric Project Engineering Evaluation. Montana Power Company, Butte, Montana, FERC Project No. 2543.

_____. 1985. Milltown Reservoir and Clark Fork River Sedimentation Study. FERC Project No. 2543. Montana Power Company, Butte, Montana. August. 22 pp.

_____. 1988. Personal communication to D. Smith, CDM, December 20.

Davis, S.N., D.J. Campbell, H.W. Bentley, and T.J. Flynn. 1985. Ground Water Tracers. National Water Well Association, Worthington, Ohio.

Dodson, M., D. Minno, P. Davis, J. Greene, G. Phillips, and M. Kerr. Undated. Three Case Studies on the Use of Ceriodaphnia as Indicators of Water Quality in Western Trout Streams. 19 pp.

Drost, W., Klotz, D., Koch, A., Moser, H., Neumaier, F., and Rauert, W. 1968. Point dilution methods of investigating ground water flow by means of radioisotopes. Water Resources Research, 4(1), pp 125-146.

Duffield, J. 1984. Refinement of Recreational Value Estimates on the Upper Clark Fork River.

Engineering Management Inc. 1982. Dam Safety Invetigations, Milltown Dam. San Francisco, California. March.

Federal Energy Regulatory Commission (FERC). 1988a. Order Amending License. The Montana Power Company. Project No. 2543-004, Montana. February 12.

_____. 1988b. Order Approving in Part and Modifying in Part a Plan to Transport Contaminated Spoil and Debris. The Montana Power Company. Project No. 2543-013, Montana. September 15.

Felmy, A.R., D.C. Givvin, and E.A. Jenne. 1983. MINTEQ - A Computer Program for Calculating Aqueous Geochemical Equilibrium. Final Project Report, EPA Contract 68-03-3089.

Harding Lawson Associates (HLA). 1986. Draft Milltown Reservoir Feasibility Study, November 12.

_____. 1987. Volume I - Draft Milltown Reservoir Data Report, Supplemental Investigations Conducted Under the Feasibility Study. Denver, Colorado. March 16.

_____. 1987a. Draft Report. Supplemental Ground Water Investigation - Arsenic Speciation - Milltown Reservoir CERCLA Site. HLA Job No. 17461.002.1.

Hydrologic Engineering Center. 1977. HEC-6 Scour and Deposition in Rivers and Reservoirs, Users Manual, technical report, U.S. Army Corps of Engineers, Davis, California, 38 p.

Hydrometrics. 1983. Summit and Deer Lodge Valleys Long Term Environmental Rehabilitation Study, Butte-Anaconda, Montana, Volume VII, Warm Springs Ponds. Prepared for the Anaconda Minerals Company, Butte, Montana.

_____. 1985. Water Resources Impacts Resulting from Proposed Rehabilitation of the Milltown Hydroelectric Project. Prepared for the Montana Power Company. May 3.

Ingman, G.L. 1985. Champion International Frenchtown Mill Discharge Permit MT-0000035, Data Report - Volumes I and II. Montana Department of Health and Environmental Sciences (MDHES). December. 589 pp. (Vol. I), 380 pp. (Vol. II).

Javandel, I. and Tsang, C.F. 1984. Capture-Zone Type Curves: A Tool for Aquifer Cleanup. Ground Water Journal. Vol. 24, No. 5, pp. 616-625.

Johns, C. and J. Moore. 1985. Metals in Bottom Sediments of Lower Clark Fork Reservoirs. Final Report submitted to Montana Water Resources Research Center, Montana State University. Bozeman, Montana.

Johnson, H. 1987. Interagency Coordination Meeting Minutes, Clark Fork River Basin Project. Missoula, Montana. February 26.

Karlsen, Barbara. 1985. Montana Department of Health and Environmental Sciences, personal communication, April 11, 1985, to S.R. Black.

Knox, R.C. 1984. Assessment of the Effectiveness of Barriers for the Retardation of Pollutant Migration. Ground Water. Vol. 22, No. 3.

Lambing, John H. 1987. Water Quality Data for the Clark Fork and Selected Tributaries from Deer Lodge to Milltown, Montana, March 1985 through June 1986. USGS Open File Report 87-110. Helena, Montana. March. 47 pp.

Marcoux, R. 1970. Western Montana Fishery Study - Inventory of Waters of the Project Area. Montana Fish and Game Deparment. Fisheries Division. Job Progress Report. Project No. F-12-R-17. Job No. I-a. 8 pp.

Mehring, S. 1985. The Impact of a Drawdown on the Movement of Heavy Metals Through a Small Impoundment on a Mine Contaminated River. University of Montana. May 17. 38 pp.

Missoula City-County Health Department, Environmental Health Division (MCCHD). 1988. Sole Source Aquifer Petition for the Missoula Valley Aquifer.

Montana Department of Fish, Wildlife, and Parks (MDFWP). 1985. Middle Clark Fork River Fishery Monitoring Study: Evaluation of the Effects of Pulp and Paper Mill Effluents on the Fish Population, Status Report. Missoula, Montana. October 15.

_____. 1986. Application for Reservations of Water in the Upper Clark Fork River Basin. Helena, Montana. November.

Montana Department of Health and Environmental Sciences - Water Quality Bureau (MDHES-WQB). 1988. Draft Study Plan: Blackfoot River Water Quality Study, 1988-1989.

Montana Department of State Lands. 1981. Final Environmental Impact Statement, Proposed South Dump Expansion, Butte, Montana.

Montana Power Company (MPC). 1985. Application for Amendment of License - Milltown Project No. 2543. Butte, Montana. July.

_____. Letter Reports from F. Pickett (Senior Biologist, MPC) to J. Knoy (RPM-EPA, Helena) of results of Milltown Dam Rehabilitation Project Water Quality Monitoring Program from September 21, 1986 through April 4, 1987.

MontPIRG. 1983. Health Study of Milltown, Montana.

Moore, J. W., Ficklin, and C. Johns. Undated. Partitioning of Arsenic and Metals in Reducing Sulfidic Sediments. Environmental Science and Technology (in press).

Moore, J., E. Brook, and C. Johns. Undated. Grain Size Partitioning of Metals in Contaminated, Coarse-Grained River Floodplain Sediment: Clark Fork River, Montana. Environmental Geology and Water Science (in press).

Moore, J. 1985a. University of Montana, personal communication, March 12 to R.L. Olsen.

_____, 1985b. Source of Metal Contamination in Milltown Reservoir, Montana: An Interpretation Based on Clark Fork River Bank Sediment. Report to the USEPA. Septemer 1985.

Nelson, W.H. and J.P. Dobell. 1961. Geology of the Bonner Quadrangle, Montana. U.S. Geological Survey Bulletin. 1111-F.

Parkhurst, D.L., D.C. Thorsterson, and L.N. Plummer. 1980. PHREEQE - A Computer Program for Geochemical Calculations, USGS Water Resources Investigations. 96 pp.

Peccia. 1983. Milltown Water Supply and Distribution System Study. Robert Peccia & Assoc., Inc., Helena, Montana. For the Montana Dept. of Health and Environmental Sciences, Solid Waste Management Bureau and Milltown Water Users Assoc.

Peters, Donald J. 1981. Inventory and Survey of the Lower Clark Fork, Blackfoot, and Bitterroot Rivers. 1980-1981. Montana Department of Fish, Wildlife, and Parks Job Progress Report. Project No. F-12-R-27, Job I.b.

_____. 1985. Western Montana Fishery Investigation, Inventory and Survey of the Lower Clark Fork, Blackfoot, and Bitterroot Rivers. Montana Dept. of Fish, Wildlife, and Parks, Fisheries Division. Job Progress Report. Project No. F-12-R-31. Job No. I-b.

_____. 1988. Personal communication, June 20 to L. Buchanan, CDM.

Phillips, G.R. 1982. Letter to Ken Alkema, re: Montana Department of Fish, Wildlife, and Parks, Job Progress Report by Donald J. Peters, February 1981.

_____. 1985. Relationships Between Metals, Flows and Fish Populations in The Upper Clark Fork River. Presented at Clark Fork River Symposium, Montana Academy of Sciences 45th Annual Meeting, Montana College of Mineral Science and Technology, Butte, Montana, April 19, 1985.

Rennick, R.B., R.C. Postle, and F.F. Munshower. 1984. Floral survey of Clark Fork River sediment upstream from the Milltown Dam. Montana Agric. Exp. Sta. Reclam. Res. Unit. Montana State University, Bozeman, Montana. 24 pp.

Rice, P.M. and G.J. Ray. 1984. Floral and Faunal Survey and Toxic Metal Contamination Study of the Grant-Kohrs Ranch National Historic Site. 92 pp.

_____. 1985. Heavy metals in Floodplain Deposits Along the Upper Clark Fork River. Proceedings - Clark Fork River Symposium. Montana Academy of Sciences. April 19. pp. 26-45.

Sangani, S.R., R. Olsen, T. Swain, and G. McCurry. 1988. PVOL - A Simple Mixing Cell Model Incorporating Dilution and Sorption Processes. Proprietary Code Developed at Camp Dresser & McKee Inc., Denver, Colorado.

Thomas, W.A., D.M. Gee, and R.C. MacArthur. 1981. Training Document No. 13, "Guidelines for the Calibration and Application of Computer Program HEC-6," February. 38 pp.

Udaloy, Anne G. 1988. Arsenic Mobilization in Response to the Draining and Filling of the Reservoir at Milltown, Montana. University of Montana. 140 pp.

U.S. Environmental Protection Agency (USEPA). 1976. Quality Criteria for Water. EPA 440/9-76-023. Washington, D.C.

_____. 1985a. Evaluation Criteria for Existing Data from CERCLA Study Areas.

_____. 1985b. STORET System Retrieval for CDM, Upper Clark Fork River Drainage, Retrieved by Richard Satirous, EPA Region VIII.

_____. 1986. Superfund Public Health Evaluation Manual. EPA 540/1-86/060.

_____. 1986. Quality Criteria for Water (Gold Book) Office of Water Regulations and Standards. EPA 440/5-86-001. May 1.

_____. 1987. Memorandum on ARARs.

_____. 1988. Draft Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. March.

U.S. Geological Survey (USGS). 1987. Water Resources Data for Montana (published annually).

_____. 1988. Personal communication, September 29, from Mel White (USGS, Helena) to D. Smith, CDM.

Woessner, W.W. and M.A. Popoff. 1982. Hydrogeologic Survey of Milltown, Montana and vicinity. Department of Geology, University of Montana, Missoula.

Woessner, W.W., J.M. Moore, C. Johns, M. Popoff, L. Sartor, M. Sullivan. 1984. Arsenic Source and Water Supply Remedial Action Study, Milltown, Montana. Department of Geology, University of Montana, Missoula, Montana, 448 pages.

Woessner, W.W., and J.M. Moore. 1988. Personal communication, June 14, to J. Stibrich, CDM.

Wood, J. 1986. Preliminary Analyses of Milltown Biological Samples - Interim Report. Letter Report from J. Wood (U.S. Dept. of the Interior, Fish and Wildlife Service, Billings, Montana) to J. Wardell (USEPA, Helena, Montana) dated September 8, 1986.

Workman, D. 1988. Personal communication, June 20 to L. Buchanan, CDM.

APPENDIX A

PRELIMINARY ENDANGERMENT ASSESSMENT

APPENDIX A
PRELIMINARY ENDANGERMENT ASSESSMENT[a]

1.0 INTRODUCTION

1.1 OVERVIEW

This report presents the results of a preliminary risk (endangerment) assessment of the Milltown, Montana site. The report is organized as follows:

- Identification of major exposure pathways and potential receptors;
- Identification of proposed remedial alternatives with estimated contaminant levels for each scenario;
- Hazard assessment: toxicity of contaminants and a discussion of relevant criteria;
- Risk assessment for each proposed remedial alternative;
- Conclusions, recommendations and a discussion of data gaps.

Data for this report were taken primarily from a University of Montana study of the site (Woessner et al., 1984), a report prepared by the Montana Power Company (Curtis, 1984), and available USGS and STORET (USEPA, 1985) water quality data. Outside sources have also been consulted and are referenced where appropriate.

The risk assessment deals only with the Clark Fork River below Milltown. An assessment of the Clark Fork above Milltown is not considered.

---

[a] This report was taken from Section 5 of the Final Interim Report (CDM 1986).

1.2 EXPOSURE PATHWAYS

Drainage of mining and milling wastes into the Clark Fork River has resulted in a buildup of contaminated sediments in the Milltown reservoir. The sediments contain high levels of arsenic, cadmium, copper, iron, lead, manganese, and zinc. The buildup of contaminated sediments has resulted in the potential for exposure to heavy metals via ground water and surface water. Although arsenic is properly termed a metalloid, it will be included in the term "heavy metal" used in this section of the report.

1.2.1 GROUND WATER

Some residential ground water wells in Milltown have been contaminated with heavy metals. It is believed that the contamination is due to recharge of ground water by the Milltown reservoir. This exposure pathway has been well documented in the report by Woessner et al. (1984).

1.2.2 SURFACE WATER

Aquatic life below the Milltown dam may be affected by surface water conditions. These effects may include a reduction in species abundance and diversity and occassional fish kills. The documentation of these effects is discussed in the risk assesment section of this report. Two possible exposure mechanisms are considered in this risk assessment as possible causes of these effects: (1) high levels of suspended solids during high flow or dam drawdown conditions; and (2) high concentrations of metals in sediments released during high flow or drawdown conditions. These mechanisms are discussed in detail in later sections of the report. Depletion of oxygen due to metals or organics is not considered a possible mechanism for the following reasons.

1. Organics make up only a small fraction (about 2%, based on data in the report by Woessner et al., 1984) of the sediments in the reservoir. These organics would not exert a significant oxygen demand below the reservoir.

2. With the exception of iron, the concentrations of metals in the sediments and the consequent rates of reduction are sufficiently low that they are not expected to exert a significant oxygen demand.

3. Concentrations of iron are sufficient to contribute some oxygen demand; however, the reaction rate is slow and is not expected to be greater than the reaeration rate.

4. The minimum reaeration rate due to stream flow turbulence is estimated to be on the order of 10-100 mg/liter/day downstream of the reservoir (See Appendix F of the interim report (CDM 1986)). This should be sufficient to counterbalance any oxygen demand exerted by the sediments or metals.

1.2.3 AIR

Under existing conditions, air is not considered a significant exposure pathway. However, the suspension of particulates during construction activities is considered where appropriate under the analysis of the proposed remedial alternatives.

1.3 PROPOSED REMEDIAL ALTERNATIVES

This report provides risk assessments for two proposed remedial alternatives: the no-action alternative and the river isolation alternative. The no-action alternative is comparable to the current situation. The river isolation alternative involves isolation of the Clark Fork River via channelization or other means so that sediments from the reservoir are not carried downstream.

A more complete discussion of these and other alternatives is provided in Section 6.0 of the Interim Final Report (CDM 1986). The two alternatives evaluated in this section represent the two extreme actions: no action and a rather complete action. Other intermediate levels alternatives exist which may be the most appropriate remedial action for the site. However, the data were not available to evaluate these alternatives in terms of associated risk. The two extreme alternatives evaluations should also represent the extreme cases of risk; that is, the maximum and minimum risk.

When the alternatives are more fully developed, a more detailed risk assessment will be completed. The current assessment is preliminary and should be used to focus the final feasibility study.

1.4 AVAILABLE DATA

Two major sources of water quality data are available for use in the exposure assessment: (1) water quality data collected by the USGS under the STORET program for various sampling points above and below Milltown; and (2) pore water and sediments samples taken at Milltown by the University of Montana (Woessner et al., 1984). The available USGS and STORET water quality data for below and above Milltown (in the vicinity of Milltown) are summarized in Tables A-1 and A-2, respectively. The numbers are averages of all available samples. These data are not considered adequate for use in the risk assessment for the following reasons:

1. The data are discontinuous, i.e., the same groups of data are not available for each chemical. Therefore, comparisons might be erroneous.

2. The data do not allow any comparison of chemical concentrations versus flow rate. Such a comparison is considered important due to the large fluctuations in flow rates and the consequent increases in suspended solids.

3. The upstream data are based on fewer sampling points and fewer samples than the downstream data. Such comparison of these data sets might also be erroneous.

4. Better data are available from the University of Montana report, as is discussed below.

The data from Woessner et al. (1984) are based on a systematic sampling program of both pore water and sediments in and near the Milltown Reservoir. For this reason, the data were considered superior to the water quality data and were therefore, used in the risk assessment. The data from the University of Montana (Woessner et al., 1984) have also been validated (see Section 4.0 of the Final Interim Report (CDM 1986)) and are considered appropriate to use in a risk assessment.

TABLE A-1

METAL CONCENTRATIONS
CLARK FORK BELOW MILLTOWN

METAL	DISSOLVED ug/liter	SUSPENDED[1] ug/liter	TOTAL ug/liter
As	4.5	3.8	8.3
Cd	2.6	6.9	9.5
Cu	22.2	41.4	63.6
Fe	--	--	--
Pb	21.4	28.3	49.7
Mn	--	--	--
Zn	51.3	136.4	187.7
TSS	--	209.5[2]	--

"--" = Not calculated.

(1) = Suspended portion derived by subtracting dissolved from total.

(2) = mg/liter

Notes:

a. Table based on USGS and STORET data (USEPA, 1985).

b. Numbers represent averages of samples taken on various dates between 4/68 and 11/83.

c. Numbers are averages of seven different sampling stations.

d. Different data sets were used to derive dissolved and total concentrations.

TABLE A-2

METAL CONCENTRATIONS
CLARK FORK AND BLACKFOOT ABOVE MILLTOWN

METAL	CLARK FORK			BLACKFOOT		
	Diss. (ug/l)	Susp. (ug/l)	Total (ug/l)	Diss. (ug/l)	Susp. (ug/l)	Total (ug/l)
As	7.9	0.5	8.4	1.3	0.3	1.0
Cd	<5.	>5.2	10.2	<5.	>4.8	9.8
Cu	12.1	13.2	25.3	<10.	>1.0	11.0
Fe	--	--	--	--	--	--
Pb	<50.	>4.8	54.8	<50.	>0.	>50.
Mn	--	--	--	--	--	--
Zn	15.6	40.2	55.8	11.9	10.9	22.8
TSS	--	26.6(1)	--	--	10.0(1)	--

"--" = Not calculated.
(1) = mg/liter

Notes:

a. Table based on USGS and STORET data (USEPA, 1985).

b. Numbers represent averages of samples taken on various data between 4/68 and 11/83.

c. Numbers are averages of seven different sampling stations.

d. Different data sets were used to derive dissolved and total concentrations.

1.5 EXPOSURE ASSESSMENT

In order to perform the risk assessment of the two proposed alternatives at different flow rates, the available data from the University of Montana (Woessner et al., 1984) and the Montana Power Company (Curtis, 1984) were used to estimate total suspended solids (TSS) and suspended metals concentrations for different flow conditions. Five flow conditions were chosen. Monthly means flows for January (low flow), June (high flow), and July (intermediate flow) provided three flow conditions. Flow rates were based on data given in the Montana Power Company report (Curtis, 1984, Table 5.3). The report also mentions a "typical runoff condition" comparable to a 10-year storm and a historic flood event representing the maximum flow for the 54-year period for which records have been kept. The 10-year storm and historic flood conditions provided the fourth and fifth flow conditions.

The Power Company report (Curtis, 1984), also provides two curves of sediment loadings (i.e., tons per day of sediment versus flow rate); one for the Clark Fork above Milltown and one for the Blackfoot above Milltown. These two curves were used to estimate sediment loading and TSS levels below Milltown for the five flow conditions. Since sediment in the reservoir is also suspended and passed downstream, an additional curve was generated to estimate these quantities. This curve uses the single measurement of TSS and flow rate available in the University of Montana report (Woessner et al., 1984, page 101) and uses the same slope as the curves for sediment loading on the Clark Fork and Blackfoot Rivers. These single measurements of TSS and flow rate are the only data currently available to characterize the sediment re-suspension process; these data have not been verified, but are useful in providing an estimate of re-suspension assuming the sediment loading curve has the same slope as the curves for the Clark Fork and Blackfoot Rivers. TSS concentrations for the river isolation alternatives were calculated using only the Clark Fork and

the Blackfoot sediment loadings. Estimates of sediment loadings and TSS concentrations for the two alternatives under the five flow conditions are given in Table A-3.

The next step in the exposure assessment was to estimate the concentrations of suspended metals under the various flow conditions. This was performed by multiplying the TSS concentrations (in units of mg/l) by the concentrations of metals (in units of µg/g) in the sediments as given in the University of Montana (Woessner et al., 1984) report. For the no action alternative low flow conditions (January and July), the concentrations in the grab sediments were used. Under the no action alternative high flow conditions (June, 10-year storm, and historic flood), the core sediments data were used. The core sediments are used at the high flow conditions because it is assumed that more bed sediments would be entrained under high flow conditions. For the river isolation alternative, the upstream grab sediment concentrations were used. The values used in these calculations are summarized in Table A-4 and A-5. TSS and suspended metal concentrations for the two alternatives are summarized in Table A-6 and A-7.

1.6 ADDITIONAL EXPOSURES

An additional potential health hazard is considered in this report. A remedial alternative under consideration involves draining the reservoir and removing the contaminated sediments. The hazard to consider is the generation and transport of dust from the exposed bed sediments during excavation and hauling. Since the sediments will probably remain wet for a long period after the drainage of the reservoir, this is not considered a major source of air contaminants. However, simplified models have been used to predict the quantity of inhalable particulates generated and their concentration away from the site. The average quantity of particulates generated is estimated at 0.04 grams per second and the average concentration 600 meter downwind in Milltown is estimated at 1.43 ug/m^3.

TABLE A-3

ESTIMATED TSS CONCENTRATIONS BELOW MILLTOWN
NO ACTION AND RIVER ISOLATION ALTERNATIVES

Flow Condition	Flow[1] cfs	Clark Fork Sediment[2] Load Tons/ day	Blackfoot Sediment[3] Load Tons/ day	Reservoir Sediment[4] Tons/ day	TSS: River Isolation[5] mg/l	TSS: No Action Alternative[6] mg/l
January mean flow	1,322	13	2.6	2.2	4.4	5.0
June mean flow	8,802	600	550	260	48.5	59.4
July mean flow	3,269	60	46	23	12.0	14.6
10-year storm	23,500	7,500	13,000	3,000	23	370
Historic flood	48,000	40,000	60,000	17,000	770	900

(1) Montana Power Company report (Curtis, 1984) Table 5.3 and pp. 5-2.

(2) Montana Power Company report (Curtis, 1984) Figure 5.4.

(3) Montana Power Company report (Curtis, 1984) Figure 5.5.

(4) From a curve derived using pre-drawdown TSS measurement in University of Montana Report (Woessner et al. 1984, page 101) and slope of curves in Figures 5.4 and 5.5 in the Montana Power Company report (Curtis, 1984).

(5) Clark Fork Load + Blackfoot Load.

(6) Clark Fork Load + Blackfoot Load + Reservoir Sediment Load.

TABLE A-4

FACTORS USED TO DETERMINE ESTIMATED SUSPENDED METAL CONCENTRATIONS AT DIFFERENT FLOW RATES
NO ACTION ALTERNATIVE

Flow Conditions	Metal	Clark Fork Sediments[1] ug/g	Blackfoot Sediments[2] ug/g	Reservoir Sediments[3] ug/g
January, July mean flows	As	12	8	58
	Cd	2.6	0.7	6
	Cu	192	40	449
	Fe	16,700	21,163	22,855
	Pb	37	18	68
	Mn	600	281	1,290
	Zn	752	128	1,767
June mean flow, 10-year storm and historic flood	As	43	6	320
	Cd	3.8	1	15
	Cd	316	37	2,182
	Fe	19,530	19,467	24,609
	Pb	54	19	262
	Mn	763	255	1,648
	Zn	875	52	4,045

(1) Mean values for Clark Fork grab samples up-stream of major sediments (Woessner et al., 1984, p. 444);January and July = sample 24; June, 10-yr. and historic = samples 26, 27, 28, 31, 24.

(2) Mean values for Blackfoot samples (Woessner et al., 1984, p. 126, 146, 175); January and July = grab samples; June, 10-yr. and historic = core samples.

(3) Mean values for Clark Fork samples (Woessner et al., 1984, p. 126, 143-146); January and July = grab samples; June 10-yr. and historic = core samples.

TABLE A-5

FACTORS USED TO DETERMINE ESTIMATED SUSPENDED METAL CONCENTRATIONS AT DIFFERENT FLOW RATES RIVER ISOLATION ALTERNATIVE

Flow Conditions	Metal	Clark Fork Sediments[1] ug/g	Blackfoot Sediments[2] ug/g	Reservoir Sediments[3] ug/g
January, July mean flows	As	12	8	0
	Cd	2.6	0.7	0
	Cu	192	40	0
	Fe	16,700	21,163	0
	Pb	37	18	0
	Mn	600	281	0
	Zn	752	128	0
June mean flow, 10-year storm and historic flood	As	43	6	0
	Cd	3.8	1	0
	Cu	316	37	0
	Fe	19,530	19,467	0
	Pb	54	19	0
	Mn	763	255	0
	Zn	875	52	0

(1) Mean values for Clark Fork grab samples up-stream of major sediments (Woessner et al., 1984, p. 444); January and July = sample 24; June, 10-yr. and historic = samples 26, 27, 28, 31, 24.

(2) Mean values for Blackfoot samples (Woessner et al., 1984, p. 126, 146, 175); January and July = grab samples; June, 10-yr. and historic = core samples.

(3) Mean values for Clark Fork samples (Woessner et al., 1984, p. 126, 143-146); January and July = grab samples; June, 10-yr. and historic = core samples.

TABLE A-6

TSS AND SUSPENDED HEAVY METALS DOWNSTREAM
OF THE MILLTOWN RESERVOIR
NO ACTION ALTERNATIVE

Flow Conditions	Flow (cfs)	TSS (mg/l)	Metals (ug/l) As	Cd	Cu	Fe	Pb	Mn	Zn
1. January Mean Flow	1,322	5.0	0.08	0.01	1.0	75	0.2	3.0	3.8
2. June Mean Flow	8,802	59.4	4.7	.3	32.9	1,216	4.7	43	68
3. July Mean Flow	3,269	14.6	0.3	.04	2.7	283	0.5	8.9	10.4
4. 10-year Storm	23,500	370	22	1.4	148	7,500	23	221	306
5. Historic Flood	48,000	900	58	3.6	402	18,000	60	570	830

TABLE A-7

TSS AND SUSPENDED METALS CONCENTRATIONS
RIVER ISOLATION ALTERNATIVE

Flow Conditions	Flow (cfs)	TSS (mg/liter)	Metals (ug/liter) As	Cd	Cu	Fe	Pb	Mn	Zn
1. January Mean Flow	1,322	4.4	0.04	0.01	0.7	61	0.14	2.2	2.7
2. June Mean Flow	8,802	48.5	1.2	0.1	8.8	946	1.8	25	23
3. July Mean Flow	3,269	12.0	0.1	0.02	1.5	224	0.34	5.5	5.8
4. 10-year Storm	23,500	320	6.3	0.7	45	6,300	10.3	143	114
5. Historic Flood	48,000	770	16	1.6	115	15,000	26	355	295

The assumptions behind these figures and additional information on the models used is contained in Appendix F of the Final Interim Report (CDM 1986).

2.0 HAZARD ASSESSMENT

This section of the preliminary risk assessment presents toxicity profiles for number of the substances found in ground water or reservoir sediments at the Milltown site. The contaminants of primary concern include arsenic, cadmium, copper, iron, lead, manganese, and zinc. These heavy metals have been found at elevated concentrations at the Milltown site and may thus have adverse effects on human health, welfare, or the environment. The first part of this section summarizes the toxic effects on animals and health effects in humans, and lists applicable environmental standards and criteria. The reported adverse effects of the heavy metal contaminants of primary concern on wildlife are summarized in the second part of this section. USEPA Ambient Water Quality Criteria (AWQC) for protection of aquatic life and its uses are summarized in the Wildlife Toxicity section (Section 2.2).

2.1 HEALTH EFFECTS

2.1.1 ARSENIC

Qualitative Description of Health Effects - Acute arsenic poisoning in humans may result in gastrointestinal effects, hemolysis (destruction of red blood cells), and neuropathy (diseases affecting nerves). Chronic exposure causes characteristic toxic effects on the peripheral nervous system and, in children, effects on the central nervous system. Keratosis (skin diseases), hyperpigmentation (increased skin pigments), and possibly precancerous dermal lesions and cardiovascular injury are frequently observed sequelae of chronic exposure to arsenic. Arsenic has been found to be embryotoxic, fetotoxic, and teratogenic (causing malformations) in several animal species, but its ability to induce malformations in humans

is less well substantiated. Arsenic induces chromosome aberrations and impairs DNA repair, but is has not been shown to be a point mutagen. Epidemiology studies have shown that inhalation of arsenic is strongly associated with cancer of the lung and perhaps with hepatic angiosarcoma (a liver cancer), while exposure by ingestion has been linked to a characteristic form of dermal cancer. Although arsenic's potential as a human carcinogen has long been recognized, it is only recently that its carcinogenicity has been demonstrated in animal models. In general, the trivalent form of arsenic is more toxic than the pentavalent form (USEPA, 1980a).

Current Criteria - To estimate an ambient water quality criterion for arsenic, USEPA (USEPA, 1980a) used the data obtained in Taiwan by Tseng et al. (1968). The Weibull model was used to relate skin cancer incidence, age, and level of exposure in the drinking water. In 37 villages that had been obtaining drinking water from artesian wells with various levels of arsenic contamination for 45 years, 40,421 individuals were examined for hyperpigmentation, keratosis, skin cancer, and blackfoot disease (in which impaired peripheral circulation leads to gangrene). Also, the local well waters were analyzed for arsenic concentration. Correlations of cancer incidence with the local arsenic concentrations and with age (duration of exposure) were found. Extrapolation to low does levels from the fitted Weibull model gave 2.2 ng/liter arsenic (inclusive for trivalent and pentavalent inorganic and organic arsenic) as the concentration predicted to be associated with a lifetime risk of cancer of 10^{-6}.

The Interim Primary Drinking Water Regulation for arsenic specifies a maximum contaminant level of 50 ug/liter. In developing this maximum contaminant level, USEPA considered arsenic ingestion in food as well as in water. Accordingly, it was calculated that daily arsenic intake in water would be 100 ug, or 50 ug/liter, with a total daily intake of 1 mg. More recently, the estimated dietary arsenic consumption was greatly reduced to 780 ug/day. Because USEPA's rationale for the 50 ug/liter drinking water standard is to keep arsenic exposure from drinking water at 10% of total

ingested arsenic, a reevaluation of the standard may be warranted. Furthermore, USEPA assumes that there is no threshold dose for carcinogens, and that consequently there is no safe exposure level. This consideration is not implied in the drinking water standard.

New Information - The ambient water quality criterion for arsenic based upon the epidemiology study of Tseng et al. (1968) has recently been criticized by Calabrese (1983). He faulted the study itself for failing to determine which arsenic compounds were present or to consider other contaminants in the drinking water (noting the possible relevance of ergot alkaloids). Calabrese questioned the results of the low-dose extrapolation procedures by pointing out that a risk of 10^{-6} from 2.2 ng/liter arsenic was derived from the incidence of skin cancer in the Taiwanese population exposed to arsenic in the 300-600 ug/liter range. By the linear extrapolation assumption used, this is equivalent to saying the expected risk of this type of skin cancer would be 10^{-3} from exposure to 2 ug/liter, the average level of arsenic in drinking water in the United States, but this has not been observed. Layton et al. (1983) conducted a risk assessment on arsenic in drinking water and concluded that concentrations up to 100 ug/liter would not pose a threat to human health.

More recently epidemiology studies add further support to the association between ingestion of arsenic in drinking water (at concentrations of approximately 1 ug/liter) and skin cancer (Astolfi et al., 1981) and between inhalation exposure to arsenic and lung cancer (e.g., Lee-Feldstein, 1983: Enterline and Marsh, 1982). Several new laboratory studies have contributed evidence that arsenic has potential as an animal, as well as human, carcinogen (Ishinishi et al., 1983; Schirachi et al., 1983). One hypothetical explanation of the wide differences among the results of studies of the carcinogenic potential of arsenic is differences in the chemical form of the arsenic.

OSHA (1983) conducted a risk assessment of arsenic in the workplace. Its calculations were based upon data from epidemiology studies of the

incidence of lung cancer among workers exposed occupationally (largely by inhalation) to arsenic. The derived unit risk was 8×10^{-4} $(ug/m^3)^{-1}$. Assuming equal absorption by the inhalation and oral routes of exposure, this estimate of carcinogenic potency would imply a lifetime cancer risk of 10^{-6} from consumption of drinking water containing 3.7 ng/liter arsenic or more generally, from the ingestion of a dose of 0.1 ng/kg/day for the lifetime of the individual. This estimate would apply specifically to trivalent inorganic arsenic.

The carcinogenic potential of arsenic in humans has been amply demonstrated. The quantitative estimates of dose-response derived from Tseng et al. (1968) upon which the 1980 ambient water quality criterion was based have been disputed, but they are quite concordant with other estimates of arsenic's carcinogenic potency derived from the epidemiology data based on inhalation exposure (OSHA, 1983). Uncertainty about the chemical form of the arsenic in the water supply studies by Tseng et al. (1968) may limit the applicability of the risk assessment to other situations. The OSHA risk assesment would be applicable to trivalent inorganic arsenic.

2.1.2 CADMIUM

Qualitative Description of Health Effects - Treatment of laboratory animals with cadmium by injection results in injection-site sarcomas (cancers of the connective tissue) and testicular tumors of the Leydig cells, but the relationship between human exposure to cadmium and cancer of the prostate, lung, or kidney, as suggested by several epidemiology studies, has yet to be firmly established.

Furthermore, cadmium has not been shown to be mutagenic, although it may impair DNA repair. Cadmium is a well-studied animal teratogen, but similar potential in humans has not been convincingly demonstrated.

Cadmium bioaccumulates, particularly in the kidney and liver. Epidemiology studies have shown nonmalignant pulmonary diseases to be associated with inhalation of cadmium. Renal tubular dysfunction, of which the first sign is proteinuria, occurs at even lower levels of oral or inhalation exposure to cadmium and may be the primary defect responsible for the bone damage seen in Itai-Itai disease. Chronic exposure of humans to cadmium is also suspected to produce hypertension, anemia, sensory loss (particularly smell), endocrine alterations, and immunosuspression (USEPA, 1980b).

Current Criterion - USEPA (USEPA, 1980b) established an ambient water quality criterion for cadmium of 10 ug/liter on the basis of the "generally accepted" estimate of 200 ug/g wet weight (w.w.) of cadmium in the renal cortex as the critical concentration for renal toxicity. Friberg et al. (1974) estimated that daily ingestion of 250-350 ug cadmium over 50 years would result in such renal concentrations. The amount of cadmium that drinking water would contribute to this concentration under various exposure scenarios was found to be small (0.53-7.6%) compared to other sources of exposure (occupational, food, smoking, and ambient air). It was therefore determined that the existing drinking water standard for cadmium of 10 ug/liter was adequate to protect against health effects from ingestion of cadmium. The Interim Primary Drinking Water Regulations specify a maximum contaminant level of 10 ug/liter for cadmium.

New Information - In a bioassay in which male Wistar rats were exposed to cadmium chloride aerosols 23 hours/day at concentrations of 12.5, 25, and 50 ug/m^3 for 18 months, Takenaka et al. (1983) found a highly significant dose-response relationship in the incidence of lung carcinomas over the controls and three treatment groups: 0/38, 6/39, 20/38, and 25/35, respectively. This represents a very marked response which certainly has implications for risk assessments for airborne cadmium. In another recent study, Thun et al. (1984) showed a significant excess of lung cancer deaths among a group of cadmium smelter workers. This finding may be somewhat confounded by effects of smoking and exposure to arsenic, but USEPA (1984b) concluded that neither was sufficient to explain the observed effect. Like

the injection site sarcomas and Leydigomas (testicular cancers) reported previously, these lung carcinomas might be interpreted as carcinogenic responses only in the directly exposed tissue. The question remains of whether a systemic carcinogenic response following exposure to cadmium by ingestion could be predicted.

USEPA (1984a) based its quantitative risk assessment for inhaled cadmium on the epidemiological study by Thun et al. (1984) and performed a risk assessment on the rat study of Takenaka et al. (1983) to support the derived unit risk. The best estimate of the exposure and response of the exposed population from the Thun et al. (1984a) study gave rise to a unit risk estimate of 2.3×10^{-3} $(ug/m^3)^{-1}$, which equals an excess risk of cancer of 10^{-6} associated with lifetime exposure to a concentration of 0.4 ng/m^3 in the air. Calculations performed by USEPA (1984a) using the Takenaka et al. (1983) data indicated a unit risk of 0.156 $(ug/m^3)^{-1}$, or a risk factor approximately 2 orders of magnitude higher. Given the limitations of available data, this quantitative risk assessment appears reasonable and the use of the unit risk of 2.3×10^{-3} $(ug/m^3)^{-1}$ appears valid for cadmium exposure by inhalation.

Aughey et al. (1984) reported that treatment of male Wistar rats for only 24 weeks with 50 ppm cadmium in the drinking water produced clear symptoms of nephritis when the accumulated renal concentration of cadmium was 60 ug/g w.w. This suggests that the present ambient water quality criterion of 10 ug/liter may be less conservative than originally believed and that the current standard for cadmium should be revised downward. It suggests that the threshold tissue concentration for adverse effects on the kidney should be 60 ug/g rather than 200 ug/g, in which case the threshold daily intake would be 75-105 ug/day rather than 250-350 ug as suggested by Friberg et al. (1974).

2.1.3 COPPER

Qualitative Description of Health Effects. Copper does not appear to be carcinogenic, mutagenic, or teratogenic and is not toxic at low levels (USEPA, 1980c). In general, more attention is given to the problems associated with copper deficiency than to problems of excess copper. Only levels much higher than those present in the environment are considered toxic. Further information on copper is available in USEPA (1980c), NAS (1977), Doull et al. (1980), and Stokinger (1981).

Current Criteria - The current Ambient Water Quality Criterion (USEPA, 1980c) is 1 mg/liter based on organoleptic quality rather than toxicity. The Secondary Drinking Water Regulations also specifiy a maximum contaminant level of 1 mg/liter. The OSHA standard and the ACGIH Threshold Limit Value for inhalation exposure are both 1.0 mg/m^3.

Analysis of Current Criteria - the present criteria appear sufficient to protect human health adequately.

2.1.4 IRON

Qualitative Description of Health Effects - Some studies have indicated that inhalation exposure to high concentrations of iron oxide is associated with increased risk of lung and laryngeal cancers in hematite miners and foundry workers. However, the significance of these findings is not established since exposures were to a mixture of substances, including radon gas and decomposition products of synthetic resins. Iron dextran solutions are reported to cause injection site sarcomas in experimental animals. Some iron compounds, notably ferrous sulfate, are reported to have high mutagenic activity in test systems. Intravenous injection of high concentrations of soluble iron salts is reported to cause teratogenic effects, including hydrocephalus (water on the brain) and anophthalmia (the lack of eye development), in various species of experimental animals (ACGIH, 1980; Doull et al., 1980; NRC, 1982).

Iron is an essential element in plants and animals. However, the ingestion of excess amounts of iron produces toxic effects, primarily associated with gastrointestinal irritation. Severe poisoning may cause gastrointestinal bleeding, pneumonitis (lung inflamation), convulsions, and hepatic toxicity. A dose of about 30 grams of a soluble ferric salt is likely to be fatal in humans. Persons ingesting more than 30 mg/kg should be observed for clinical symptoms and possibly hospitalized. Chronic ingestion of excess iron may lead to hemosiderosis or hemochromatosis. Hemosiderosis is the deposition of an iron-containing glycoprotein in body tissues. Hemochromatosis involves accummulation of excessive amounts of iron in the liver and other tissues and development of liver cirrhosis. Long-term inhalation exposure to iron-containing dusts and fumes, especially iron oxide, can produce siderosis (arc-welders disease). This condition is considered to be a type of benign pneumoconiosis (lung disease due to dust inhalation) that does not progress to fibrosis (excess growth of fibrous connective tissue). Exposure to aerosols and mists of soluble iron salts may produce respiratory and skin irritation. The toxic effects of iron in experimental animals are similar to those observed in humans (ACGIH, 1980; Doull et al., 1980; NRC, 1982).

Current Criteria - The Secondary Drinking Water Regulations specifiy a maximum contaminant level of 0.3 mg/liter for iron. These regulations control contaminants in drinking water that primarily affect the aesthetic qualities relating to the public acceptance of drinking water. At considerably higher concentrations of these contaminants, health implications may exist in addition to aesthetic degradation. The regulations are not federally enforceable but are intended as guidelines for the states.

Analysis of Current Criteria - The available criteria for prevention of aesthetic degradation appear sufficient to protect human health with a considerable margin-of-safety.

2.1.5 LEAD

Evaluation of Health Effects - Lead can produce toxic effects in humans as a result of exposure by inhalation of contaminated air or dusts, or by ingestion of contaminated food or water (USEPA, 1984b). Lead has been shown to be teratogenic in a number of animal studies and caused an increased incidence of stillbirths and miscarriages in occupationally exposed women (USEPA, 1980d). The reported level of lead in the air in the epidemiologic study was 75 ug/m^3, for an approximate dose of 0.025 mg/kg/day. Renal dysfunction has been associated with blood lead levels as low as 40 ug/dl with the renal changes being produced at a number of sites in the kidney.

The major effects caused by exposure to lead are toxicity to the hematopoietic system (the body's macrophage system) and neurological effects. Synthesis of heme (part of the hemoglobin of red blood cells) is inhibited by the effects of lead on a number of steps in the biosynthetic pathway. Specifically, lead stimulates delta-aminolevulinic acid systhetase (ALA-S) and therefore increases the production of delta-aminolevulinic acid (ALA); it inhibits the activity of delta-aminolevulinic acid dehydratase (ALA-D) and therefore decreases the production of porphobilinogen from ALA; and finally, lead inhibits the insertion of iron into protoporphyrin to form heme. No threshold has been found for this effect on heme production. Decreased heme production caused by lead is important for its effect on the erythropoietic (red blood cell production) system because it can cause anemia due to decreased hemoglobin production. Decreased heme production can have deleterious effects on other heme-containing proteins, such as cytochrome P-450 which functions in the body to detoxify certain chemicals.

The neurotoxic effects associated with exposure to lead are of two types. Blood lead levels of over 80 ug/dl in children and over 100 ug/dl in sensitive adults can cause severe irreversible brain damage, brain disease and possibly death. Persons with these high levels may be asymptomatic or

show only slight signs of intoxication but rapid deterioration can occur and in children permanent learning disabilities are seen at these levels even if no overt symptoms of lead poisoning are observed.

Although exposure to high lead levels has very severe neurological effects, exposure of children and pregnant women to low levels of lead may also cause significant neurotoxicity. Children and fetuses with blood levels of lead of 30 ug/dl and lower, may suffer signigicant neurobehavioral deficits. This would be manifested in a slight, but potentially very important decrease in learning ability for an affected child. This type of effect is toxicologically very important because there may not be an actual threshold dose below which an effect would not occur. The permanently impaired learning ability associated with such low level exposure may be impossible to detect clinically.

Current Criteria - The OSHA Standard for lead in air is 50 ug/m^3; the NIOSH Recommended Standard is 100 ug/m^3; and the ACGIH Threshold Limit Value is 150 ug/m^3. The standard for ambient air is 1.5 ug/m^3. The USEPA Interim Primary Drinking Water Standard and Ambient Water Quality Criterion are both 50 ug/liter (USEPA, 1980d; 47 CFR 10998, 1982).

The Center for Disease Control (CDC) currently defines "lead toxicity" in a child as a blood lead level $\geq$50 ug/dl. However, CDC is presently revising its criteria for lead toxicity to blood lead levels $\geq$ 25 ug/dl and EP $\geq$35 ug/dl (Schilling et al., 1984).

Analysis of Current Criteria - The standards for lead in air all appear sufficient to protect against severe toxicological effects in workers. The standard for ambient air is probably sufficient to protect against severe overt effects of lead toxicity but may not provide an adequate margin of safety to protect aganist subclinical neurotoxic effects. The standards for drinking water also seem sufficient to protect against severe overt health effects, but may not provide an adequate margin of safety to protect against less severe but important subclinical effects.

2.1.6 MANGANESE

Qualitative Description of Health Effects - Toxic effects of manganese have been studied primarily in workers exposed by inhalation to manganese-containing dust. Exposure to high levels of manganese causes pneumonitis in exposed workers. More importantly, chronic exposure has been associated with neurological effects similar to Parkinson's disease with signs and symptoms including speech disturbances, a masklike face, tremors, difficulty in walking, and sexual disturbance (Stokinger, 1981). The disease, manganism, is progressive, first manifested as increased irritability, difficulty in walking, unusual behavior, and speech disturbances before progressing to the more serious and not completely reversible condition resembling Parkinson's disease. Although exposure in these cases was by inhalation, approximately 60% of the manganese that is inhaled is subsequently coughed up and swallowed and then may absorbed through the lining of the gut. One case study reported apparent manganism associated with extremely high levels of manganese in a drinking water well, further suggesting that ingestion, as well as inhalation, is an important route of exposure. Chronic exposure to manganese also causes increased production of erythrocytes, with consequent increases in hemoglobin values and erythrocyte counts.

Current Criteria - The OSHA standard and the ACGIH Threshold Limit Value for manganese dust are both 5 mg/m^3 in the air, corresponding to approxiamtely 1 mg/kg/day for man. The Secondary Drinking Water Regulations specify a maximum contaminant level of 0.05 mg/liter for manganese. These regulations control contaminants in drinking water that primarily affect the aesthetic qualities relating to the public acceptance of drinking water. At considerably higher concentrations of these contaminants, health implications may exist in addition to aesthetic degradation. The regulations are not Federally enforceable but are intended as guidelines for the states.

Analysis of Current Criteria - The current standards are based on a lowest observed effect level (LOEL) of 30 mg/m^3 for chronic manganese toxicity by inhalation and therefore have a safety factor of less than one order of magnitude. However, no adverse effects have been seen at this level, and therefore it is probably sufficient to prevent toxic effects in humans exposed to airborne manganese. Undesirable taste and discoloration of the water occur at concentrations greater than 0.05 mg/liter and should prevent ingestion of toxic levels of manganese, but it clearly did not in the Kawamura et al. (1941 in NAS, 1973) study. As no water concentrations were presented with this study, a maximum total dose level of 0.5 mg/kg/day is determined from the inhalation studies to be adequate to prevent toxic effects in humans. Assuming daily intake of 2 liters of drinking water by a 70 kg. person, this would correspond to a concentration of about 17.5 mg/liter.

2.1.7 ZINC

Qualitative Evaluation of Health Effects - Zinc is an essential element in the body and more problems have been associated with zinc deficiencies than with exposure to elevated concentrations. However, zinc does exhibit some toxic effects a high levels. Skin and eye irritation are produced by contact with high concentrations of zinc chloride. Ingestion of excessive amounts of zinc may cause fever, vomiting, stomach cramps, and diarrhea. In a study on rats, ingestion of 2.5% zinc in the diet (providing a dose of approximately 125 mg/kg/day) produced growth retardation; hypochromic anemia, and defective mineralization of bone. Dietary levels less than 0.25% had no effect in the same study (ACGIH, 1980; Doull et al., 1980; USEPA, 1980e).

Current Criteria - The USEPA Ambient Water Quality Criterion and Secondary Drinking Water Standard are both 5 mg/liter based on organoleptic qualities. At considerably higher concentrations of these contaminants, health implications may exist in addition to aesthetic degradation.

Analysis of Current Criteria - The current criteria appear to be sufficient to prevent human health hazards due to exposure to zinc.

2.2 TOXICITY TO WILDLIFE

2.2.1 ARSENIC

Various inorganic forms of arsenic appear to have similar levels of toxicity; they all seem to be much more toxic than organic forms. Acute toxicity to adult freshwater animals occurs at levels of trivalent arsenic as low as 812 ug/liter. Acute toxicity occurs at levels as low as 40 ug/liter in early life stages of aquatic organisms. Arsenic toxicity does not appear to increase greatly with chronic exposure, and it does not seem that arsenic is bioconcentrated to a great degree. Trivalent arsenic may be toxic to freshwater plants at concentrations as low as 2,320 ug/liter (USEPA, 1980a; USEPA, 1983a).

To protect freshwater aquatic life and its uses, the USEPA Ambient Water Quality Criteria (AWQC) recommend that the average concentrations of dissolved trivalent inorganic arsenic (operationally defined as the trivalent inorganic arsenic that passes through a 0.45 um filter) not exceed 72 ug/liter, and that the concentration never exceed 140 ug/liter. Concentrations may be between these average and maximum values for up to 96 hours. Not enough data were available for USEPA to recommend AWQC for pentavalent inorganic arsenic or organic arsenic compounds. However, pentavalent inorganic arsenic is acutely toxic to freshwater aquatic animals at concentrations as low as 850 ug/liter and to plants at 48 ug/liter. Monosodium methanearsenate is acutely toxic to aquatic animals at concentrations as low as 1,900 ug/liter (USEPA, 1983a; 49 Federal Register 4551-4554, 1984).

Arsenic poisoning is a rare toxic syndrome among domestic animals. Arsenic causes hyperemia (excessive organ blood content) and edema (accummulation of fluid in cells, tissues, or body cavities) of the gastrointestinal

tract, hemorrhage of the cardiac serosal surfaces and peritoneum, and pulmonary congestion and edema; and it may cause liver necrosis. Information on arsenic toxicity to terrestrial wildlife was not reported in the literature reviewed.

2.2.2 CADMIUM

The acute LC_{50} for cold freshwater fish and invertebrates generally ranged from 10 to 100 ug/liter; salmonids are much more sensitive than other organisms. Chronic tests have been performed and show that cadmium has cumulative toxicity and acute-chronic ratios that range from 66 to 431. Bioconcentration factors were generally less than 1,000 but were as high as 10,000 for some freshwater fish species. Freshwater aquatic plants are affected by cadmium at concentrations ranging from 2 to 7.4 ug/liter. The USEPA AWQC recommend that the concentration of active cadmium (operationally defined as the cadmium that passes through a 0.45 um membrane filter after the sample is acidified to pH=4 with nitric acid) not exceed the numerical value given by $e^{(1.16[\ln(\text{hardness})]-3.841)}$ (USEPA, 1983b; 49 Federal Register 4551-4554, 1984).

No adverse effects on domestic or wild animals were reported in the studies reviewed.

2.2.3 COPPER

Mean acute toxicity values for a large number of freshwater animals range from 7.2 ug/liter for Daphnia pulicaria to 10,200 ug/liter for the bluegill. Toxicity tends to decrease as hardness, alkalinity, and total organic carbon increase. Chronic values for a variety of freshwater species range from 3.9 ug/liter for brook trout to 60.4 ug/liter for northern pike. Hardness does not appear to affect chronic toxicity. The acute-chronic ratios for different species range from 3 to 156. The more sensitive species tend to have lower ratios than the less sensitive species. In addition, the ratio seems to increase with hardness. Copper

toxicity has been tested on a wide variety of freshwater aquatic plant species. Results of these studies indicate that protection of animal species should also provide adequate protection of plants (USEPA, 1980c; USEPA, 1983c).

To protect freshwater aquatic life and its uses, the USEPA AWQC recommend that the average concentration of active copper (operationally defined as the copper that passes through a 0.45 um membrane filter after the sample is acidified to pH=4 with nitric acid) not exceed the numerical value given by $e^{(0.905[(\ln(\text{hardness})]-1.785)}$, and that the concentration never exceed $e^{(0.905[\ln(\text{hardness})]-1.413)}$. Concentrations may be between these average and maximum values for up to 96 hours (USEPA, 1983c; 49 Federal Register 4551-4554, 1984).

2.2.4 IRON

USEPA did not establish an ambient water quality criterion for iron in its 1980 series of criteria documents, but had earlier recommended a level of 1,000 ug/liter for <u>total</u> iron for protection of aquatic life (USEPA, 1976). The same level was recommended in a recent criterion development study for the Commonwealth of Kentucky (Birge et al., 1985). This recommendation was based on chronic toxicity tests for <u>Daphnia</u> and fathead minnows, which yielded chronic values of 970 ug/liter and 560 ug/liter, respectively, for <u>total</u> iron. These laboratory studies were validated in field studies in which <u>total recoverable</u> iron was measured (Birge et al., 1985).

The available data are not adequate to further characterize the toxicity of iron to wildlife or domestic animals.

2.2.5 LEAD

Freshwater vertebrates and invertebrates are more sensitive to lead in soft water than in hard water. At a hardness of about 50 mg/liter $CaCO_3$, the median effect concentrations for nine families range from 140 ug/liter to

236,600 ug/liter. Chronic values for Daphnia magna and the rainbow trout are 12.26 ug/liter and 83.08 ug/liter, respectively, at a hardness of about 50 mg/liter. Acute-chronic ratios calculated for three freshwater species ranged from 18 to 62. Bioconcentration factors, ranging from 42 for young brook trout to 1,700 for a snail, were reported. Freshwater algae show an inhibition of growth at concentration above 500 ug/liter (USEPA, 1980d; USEPA, 1983d).

To protect freshwater aquatic life and its uses, the USEPA AWQC recommend that the average concentration of active lead (operationally defined as the lead that passes through a 0.45 um membrane filter after the sample is acidified to pH=4 with nitric acid) not exceed the numerical value given by $e^{(1.34[\ln(\text{hardness})]-5.2245)}$, and that the concentration never exceed the value given by $e^{(1.34[\ln(\text{hardness})]-2.014)}$. Concentrations may be between these average and maximum values for up to 96 hours (USEPA, 1983d; 49 Federal Register 4551-4554, 1984).

Although lead is known to occur in the tissues of many free-living wild animals, including birds, mammals, fishes, and invertebrates, reports of poisoning usually involve waterfowl. There is evidence that lead, at concentrations occasionally found near roadsides and smelters, can eliminate or reduce populations of bacteria and fungi on leaf surfaces and in soil. Many of these microorganism play key roles in the decomposer food chain (USEPA, 1984b).

2.2.6 MANGANESE

Adequate data for characterization of the toxicity of manganese to wildlife or domestic animals are not available.

A 48-hour LC_{50} value of 16 mg/liter of manganese is reported for embryos of the oyster Crassostrea virginica. For the softshell clan Mya arenaria, a 168-hour LC_{50} value of 300 mg/liter is reported (Eisler, 1977). McKee and Wolf (1963, as reported in USEPA, 1976) summarized data on toxicity of

manganese to freshwater aquatic life. Ions of manganese are rarely found at concentrations above 1 mg/liter. The tolerance values reported range from 1.5 mg/liter to over 1,000 mg/liter. Thus, manganese is not considered to be a problem in fresh waters. Permanganates have been reported to kill fish in 8 to 18 hours at concentrations of 2.2 to 4.1 mg/liter, but permanganates are not persistent because they rapidly oxidize organic materials and are thereby reduced and rendered nontoxic (USEPA, 1976).

2.2.7 ZINC

Zinc produces acute toxicity in freshwater organisms over a range of concentrations from 90 to 58,100 ug/liter and appears to be less toxic in harder water. Acute toxicity is similar for freshwater fish and invertebrates. Chronic values range form 47 to 852 ug/liter and appear to be relatively unaffected by hardness. A final acute-chronic ratio for freshwater species of 3.0 has been reported. Although most freshwater plants appear to be insensitive to zinc, one species, the alga Selenastrum capricornutum, exhibited toxic effects at concentrations from 30 to 700 ug/liter (USEPA, 1980e).

To protect freshwater aquatic life and its uses, the USEPA AWQC recommended that the average concentration of total recoverable zinc not exceed 47 ug/liter, and that the concentration (in ug/liter) never exceed the numerical value given by $e^{(0.83[\ln(\text{hardness})]+1.95)}$.

2.2.8 Limitations of Assessment of Risk to Aquatic Life

Although the effect of water hardness on metal uptake and toxicity is known, the effects of synergism or antagonism among chemical species in vivo is relatively little known. Likewise, the operation of potentially stressful aquatic environmental factors such as suspended sediments complicates the prediction of toxicity responses. Also very important is

that fact that different species can be expected to vary widely in their response to a given set of ambient metal concentrations and other environmental factors.

3.0 RISK ASSESSMENT

The potential for adverse effects on human health or the environment occurring at the Milltown, Montana site is related both to the conditions and routes of exposure, and to the concentration and inherent toxicity of the compounds in question. Consequently, the potential adverse effects associated with the exposure scenarios identified in the Introductory section (Section 1) are examined. The compounds of primary concern discussed in the Hazard Assessment section (Section 2) will be considered in this analysis. Adverse effects associated with exposure to contaminated ground water, surface water, and soil are evaluated separately.

3.1 RISKS ASSOCIATED WITH EXPOSURE TO CONTAMINATED GROUND WATER

Ground water from a number of public, private, and monitoring wells in the Milltown area has been found to contain several ground water constituents at concentrations above background levels. Of greatest concern in this regard are the high concentrations of heavy metal observed, and the potential health risks to human consumers of this water. The source of this contamination appears to be the heavy metal-laden sediments in the Milltown Reservoir.

3.1.1 NO REMEDIAL ACTION

At least four wells that formerly supplied drinking water to approximately 33 Milltown residences have been abondoned, primarily because of high arsenic concentrations. Residents stopped using these wells as a source of domestic water in 1981. Maximum concentrations of the compounds of primary concern detected in these wells from 1981-1984 are shown in Table A-8. Continued monitoring of these wells and more recently installed monitoring

TABLE A-8

CONTAMINANTS OF PRIMARY CONCERN AT THE MILLTOWN, MONTANA SITE:
OF CONCENTRATIONS IN GROUND WATER WITH APPLICABLE STANDARDS AND CRITERIA
(All concentrations in ug/liter)

Compound	Maximum Ground Water Concentrations in Former Water Supply Wells from 1981-1984	Interim Primary Drinking Water Regulations	Secondary Drinking Water Regulations	Quality Criteria
Arsenic	825	50	--	0.0022[2]
Cadmium	NA[1]	10	--	10
Copper	50	--	1,000	1,000[3]
Iron	24,000	--	300	--
Lead	NA[1]	50	--	50
Manganese	14,000	--	50	--
Zinc	806	--	5,000	5,000[3]

(1) Not analyzed

(2) Value associated with an incremental lifetime cancer risk of 10^{-6}

(3) Based on organoleptic data, and designed to control undesirable taste and odor of ambient water

wells shows that contamination of ground water in the vicinity of the reservoir with relatively high heavy metal concentrations is still present. Estimation of the risks associated with ingestion of water contaminated at the levels presented in Table A-8 are made in this section and probably represent a rough "worst case" risk assessment. Comparison of observed concentrations of heavy metals with applicable drinking water regulation or suggested guidelines provides an indication of the risks associated with exposure to these contaminants (see Table A-8).

As shown in Table A-8, the highest arsenic concentration seen in former domestic supply wells exceeds the Interim Primary Drinking Water Standard by a factor of more than 16. The potential risks associated with ingestion of groundwater contaminated with arsenic, a human carcinogen, can be estimated by comparing the exposure rate with the unit risk for this compound. A unit risk is the possible lifetime cancer risk occurring in a hypothetical population in which all individuals are exposed continuously for lifetime to a concentration of 1 ug/liter of a compound in drinking water. The unit risk for arsenic, derived from the USEPA Ambient Water Quality Criteria for Arsenic (1980a), is 4.55×10^{-4} $(ug/liter)^{-1}$, and the cancer risk associated with ingestion of water containing arsenic at a concentration of 825 ug/liter is 0.375. This calculation involves the assumption that arsenic in the ground water at Milltown is of similar chemical form to that in the wells in Taiwan on which the unit risk is based. This has not been verified by chemical analysis. However, even if the carcinogenic risks posed by arsenic could be discounted, the concentrations observed in some of the wells in the Milltown area would pose unacceptable risks of other chronic toxic effects of arsenic to individuals using ground water contaminated at these levels.
Iron and manganese have also been detected in ground water at concentrations greatly exceeding recommended guidelines. The applicable guidelines for these metals are the Secondary Drinking Water Regulations which are designed primarily to preserve the aesthetic qualities relating to public acceptance of drinking water. At concentrations considerably higher than these guidelines, health implications may exist in addition to

aesthetic degradation. The concentrations of iron present in some of the Milltown ground water samples may make this water unacceptable for human use because of poor taste, odor, and color qualities. However, chronic toxic effects in monogastric animals only appear at dietary intakes 340 to 1,700 times greater than required levels. The daily requirements for humans are approximately 1.0 and 1.5 mg for males and females respectively (NRC 1980). Consequently, adverse effects would not be expected to occur even after ingestion of water contaminated at levels seen in some of the Milltown ground water samples. Observed concentrations of manganese in Milltown ground water may also make this water unacceptable for aesthetic reasons. Although no evidence of manganese toxicity has been observed in individuals consuming as much as 8 to 9 mg/day, circumstantial evidence indicates that a dose of about 20 mg/day can potentially produce manganese intoxication (NRC 1980). Ingestion of water containing 14,000 ug/liter of manganese could result in daily doses exceeding 20 mg/day, and therefore it must be concluded that adverse health effects could result.

Observed concentrations of copper and zinc do not exceed suggested drinking water guidelines and would not be expected to cause adverse health effects. Although ground water samples were not analyzed for cadmium or lead, based on concentrations present in the Milltown Reservoir sediment it appears that concentrations of these metals may also exceed recommended guidelines and may thus pose unacceptable human health risks. However, the present conditions in the reservoir may limit the mobility of cadmium and lead and thus the concentrations in the ground water.

3.1.2 RIVER ISOLATION

The present state of understanding of the ground water system of the area is not sufficiently quantitative to predict the rate and absolute limit of improvement to ground water quality as a result of river isolation. It is thought that the quality of ground water would slowly improve as infiltration or river or reservoir water through the sediments and into the ground water decreased. As ground water quality improved, the risks

detailed above under the no action alternative would decline. The rate of decline and the ultimate level of risk is unknown.

3.2 RISKS ASSOCIATED WITH EXPOSURE TO CONTAMINATED SURFACE WATER

The most important potential risks associated with exposure to surface water in the vicinity of the Milltown site appear to be related to downstream transport of contaminated sediments that have collected in the Milltown Reservoir. Movement of sediments from the reservoir into the Clark Fork River could adversely affect wildlife, especially aquatic life, below the Milltown Dam. Although human exposure to surface water via recreational use of the Clark Fork River could also occur, exposures would probably be intermittent and result in low contaminant intakes. Potential adverse effects occurring under these conditions would therefore probably be insignificant in comparison with more general environmental effects. Consequently, this section primarily addresses the potential risks to aquatic organisms and wildlife resulting from exposure to heavy metals originating in the Milltown Reservoir. The potential exposure effects associated with the exposure scenarios described in Section 1 will be evaluated.

Evaluation of the potential for adverse effects occurring in the Clark Fork River is based on comparison of estimated total suspended solid (TSS) and metal loadings immediately below the Milltown Dam with recommended Ambient Water Quality Criteria (AWQC) or other applicable guidelines. Because data concerning Clark Fork River water quality in the vicinity of the Milltown Reservoir are available, total suspended sediment (TSS) loadings under a variety of flow conditions were estimated as described in Section 1. The total metal concentrations associated with these TSS loadings were also calculated according to the methodology described in Section 1, and are used as a basis for risk evaluation. TSS and metal concentrations for the no-action and river isolation scenarios are presented in Tables A-5 and A-6, respectively. Applicable guidelines for protection of freshwater aquatic life are shown on Table A-9.

TABLE A-9

CRITERIA FOR PROTECTION OF FRESHWATER AQUATIC LIFE
(All concentrations in ug/liter)

	Ambient Water Quality Criteria[1]	Other Suqggested Guidelines[2]
Arsenic[5]	72[3] 140[4]	-
Cadmium	9	-
Copper[5]	19[3] 28[4]	-
Iron	-	1,000
Lead[5]	6[3] 151[4]	-
Manganese	-	1,500
Zinc[5]	47[3] 547[4]	-
TSS[6]	-	25,000 (for excellent fisheries) 25,000 - 80,000 (for good to moderate fisheries) 80,000 - 400,000 (for fair to poor fisheries)

(1) For protection of freshwater aquatic life

(2) Based on tolerance levels seen in limited testing with freshwater aquatic species

(3) Average concentration; water hardness of 190 mg/liter is assumed where necessary to calculate the guideline limit

(4) Maximum concentration; water hardness of 190 mg/liter is assumed where necessary to calculate the guideline limit

(5) Concentration may be between the average and maximum values for up to 96 hours

(6) USEPA (1976)

The applicable criteria for protection of aquatic life presented in Table A-9 generally specify exposure to dissolved materials or to specific ionic species, although zinc criterion, which is based on exposure to total recoverable zinc, is an exception. Because information quantifying metal concentrations in the Clark Fork River in terms of dissolved species are very limited, comparison of total metal concentrations associated with estimated TSS loadings forms the basis for this risk assessment. A number of considerations appear to make this a reasonable alternative approach. First, USGS and STORET data (USEPA, 1985) plus analyses of surface water samples below of the Milltown Reservoir, show that ratios of dissolved metal concentrations to total metal concentrations vary greatly (See Table A-10). Although the available data are sufficient to determine a rough order of magnitude ratio between dissolved and total metals, the data are not sufficient to estimate specific dissolved concentrations directly. In addition, a portion of the non-dissolved metals transported downstream is likely to be ingested by fish or other aquatic organisms, or to come in contact with the gills or other body surfaces. Thus, some of the non-dissolved metals also could become biologically available to aquatic organisms. Finally, as a matter of policy, EPA suggests that measurement of both dissolved and total metals can be useful in assessing potential adverse effects on aquatic life. For example, there is more cause for concern if total metal concentrations are above the applicable criterion, even if dissolved metal concentrations are below the criterion, than there is if both are below the criterion. In the absence of adequate data concerning dissolved metal concentrations, it thus appears probable that comparison of total metal concentrations with the criteria would be appropriate (USEPA, 1983 a, b, c, d; F. Gostomski, USEPA Criteria and Standards Division, personal communication). In any event, for purposes of this risk assessment, where estimated total metal concentrations are relatively close to the recommended criteria, the proportion of the contaminant likely to be dissolved will be considered.

TABLE A-10

RATIOS OF DISSOLVED TO TOTAL METALS
CONCENTRATION BELOW MILLTOWN

METAL	RATIO RANGE
As	0.36 - 0.92
Cd	--
Cu	0.08 - 0.68
Pb	0.02 - 0.20
Zn	0.08 - 0.42

"--" = No Data.

Comparisons of estimated TSS and metal concentrations with water quality criteria for the no-action and river isolation alternatives are summarized in Table A-11 and discussed below.

3.2.1 No remedial action

Estimated TSS loadings and heavy metal concentrations for the flow conditions analyzed are shown in Tables A-6. Although long-term TSS loadings in the range of 80 to 400 mg/liter may only support fair to poor fisheries, relatively short-term exposure (several hours a day) to several thousand parts per million may not be lethal to existing fish population (USEPA, 1976). Beccause moderately elevated concentrations would only occur for short periods of times, such as during storms, it is unlikely that estimated TSS concentrations expected to occur below the Milltown Dam would be responsible for acute lethality in exposed aquatic species. However, the cumulative effects of increased sedimentation could degrade the environment by disrupting benthic populations, damaging spawning beds, and removing dissolved oxygen from overlying waters.

Comparison of predicted heavy metal loadings in Tables A-6 with recommended criteria for protection of aquatic life in Tables A-9 shows that adverse effects on aquatic life could occur under some of the representative flow conditions (e.g., June mean flows). Reported differences in species abundances and diversity above and below the Milltown Reservoir may thus be related to the presence of metal contamination under these conditions. Isolated and relatiavely poorly documented reports of fish kills may also be important in this regard. The species potentially affected could include locally important species such as trout, as well as plants, benthic organisms, and other types of fish. June mean flow concentrations of copper, iron, lead, and zinc exceed recommended guidelines. Although predicted concentrations estimated to occur under these "normal" flow conditions do not greatly exceed the guidelines and severe acute effects would not be expected, some reduction in species diversity or abundance is likely to occur.

TABLE A-11

COMPARISON OF ESTIMATED TSS AND METALS
CONCENTRATIONS WITH WATER QUALITY CRITERIA
NO ACTION AND RIVER ISOLATION ALTERNATIVE

Parameter:	TSS		As		Cd		Cu		Fe		Pb		Mn		Zn	
Alternative:	NA	RI	NA	RI	NA	RI	NA	RI	NA	RI	NA	RI	NA	RI	NA	RI
Flow Condition[1]																
January	Ex	Ex	B	B	B	B	B	B	B	B	B	B	B	B	B	B
June	GM	GM	B	B	B	B	A	B	A	B	A[2]	B	B	B	A	B
July	EX	EX	B	B	B	B	B	B	B	B	B	B	B	B	B	B
10-year	FP	FP	B	B	B	B	A	A[2]	A	A	B	B	B	B	B	B
Flood	P	P	B	B	B	B	A	A[2]	A	A	B	B	B	B	A	B

Notes:

NA = No Action Alternative
RI = River Isolation Alternative

B = Below Criterion
A = Above Criterion

EX = Excellent
GM = Good to Moderate
FP = Fair to Poor
P = Poor

(1) Concentrations for January, June and July flows were compared with average concentration guidelines where applicable; 10-year storm and flood flow concentrations were compared with maximum concentration guidelines.

(2) Estimated dissolved concentrations based on dissolved to total metal ratios in Table 5.10 are below recommended criteria.

Under 10-year storm and historic flood conditions, the total concentrations of copper, iron, and zinc could potentially exceed recommended guidlelines, some by a large amount. Although these conditions would occur relatively rarely, the predicted concentrations of metals, if biologically available to aquatic species, could produce acute toxic effects and fish kills.

No information concerning bioaccumulation of heavy metals by aquatic organisms in the vicinity of the Milltown site is available. However, consumption of contaminated aquatic organisms by humans, predatory birds, mammals, or other aquatic organisms could pose potential hazards. Among the heavy metal contaminants present in the reservoir sediments, cadmium and lead are of primary concern because they are stored in tissues of animals and plants and are chronically toxic at relatively low levels of exposure.

3.2.2 RIVER ISOLATION

Estimated TSS and heavy metal loadings associated with flow conditions for a scenario in which the Clark Fork River is isolated from the reservoir are shown in Table A-7. For this scenario, TSS and heavy metals are expected to be lower under all flow conditions than for the no-action alternative.

Expected TSS loadings would result in similar conditions to those described for the no-action alternative. That is, although moderately elevated TSS concentrations would probably occur for short periods of time, such as during storms, acute lethal effects would not be expected in exposed aquatic species. However, the cumulative effects of increased sedimentation could result in significant effects.

Among the metals, only concentrations of copper and iron during 10-year storm and historic flood conditions exceed recommended guidelines. However, estimated dissolved copper concentrations based on the dissolved to total metal concentration ratios in Table A-10 may be below recommended

guidelines, and thus may not pose significant environmental risks. Exposure to iron at concentrations predicted for the 10-year storm and historic flood conditions could produce acute toxic effects in aquatic organisms. The significance of such relatively infrequent and short-term exposures on aquatic life and the environment cannot be assessed without more detailed study of the area.

3.3 RISKS ASSOCIATED WITH EXPOSURE TO CONTAMINATED SOIL

As discussed in the introductory section, human exposure to contaminated soil dispersed into the atmosphere during excavation operations associated with a sediment removal scenario could occur. Using a rudimentary model described in Appendix F of the Final Interim Report (CDM 1986) it is estimated that during excavation operations a suspended particulate concentration of 1.43 ug/m^3 could potentially occur 600 meters downwind from the reservoir. This estimate is far below any of the applicable standards shown in Table A-12. Consequently, adverse effects on human health are not likely to occur. An adequate safety plan for the excavation site is expected to be sufficient to protect workers in the area. The low concentrations of particulates potentially generated at the site are not likely to adversely affect wildlife or the environment in the vicinity of the site.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The primary conclusions of the risk assessment are as follows:

- Under a no-action alternative, adverse effects on aquatic life could potentially occur under high flow, storm conditions due to high surface water concentrations of copper, iron, lead, and zinc.

TABLE A-12

AIR QUALITY STANDARDS
(All concentrations in mg/m^3)

	ACGIH TLV	AAQS
Arsenic	2.0	--
Cadmium (dust)	0.05	--
Copper (dust)	1.0	--
Iron (soluble salts)	1.0	--
Lead (dust)	0.15	--
Manganese (dust)	5.0	--
Zinc (nuisance dust standard)	10. (total dust) 5. (respirable dust)	-- --
Particulates	--	.075

Severe acute effects would not be expected under low or normal flow conditions although some reduction in species diversity or abundance could occur.

- o TSS and heavy metal loadings will be reduced under the river isolation alternative; however, it is estimated that at the 10-year and historic flood conditions, high concentrations of copper and iron may be present.

4.2 RECOMMENDATIONS

Additional data are required in order to adequately evaluate the risks to downstream aquatic life and to evaluate different remedial alternatives. It is recommended that the following data be collected:

- o TSS, dissolved oxygen, and dissolved/suspended heavy metals concentrations upstream and downstream of the reservoir under various flow conditions. Data should also be collected during storm events.

- o Biological diversity and abundance of species both upstream and downstream of the reservoir.

- o Tissue bioassays of aquatic organisms upstream and downstream of the reservoir would help to determine if bioaccumulation of heavy metals and subsequent ingestion by wildlife or humans could potentially occur.

- o Characterization of sensitive species in the Milltown area and determination of risks to these species associated with expected TSS and metal concentrations under alternative scenarios.

LIST OF REFERENCES

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIB). 1980. Documentation of the Threshold Limit Values. 4th ed. Cincinnati, Ohio. 488 pages

ASTOLFI, E., MACCAGNO, A., GARCIA-FERNANDEZ, J.C., VACCARO, R. and STIMOLA, R. 1981. Relation between arsenic in drinking water and skin cancer. Biol. Trace Elem. Res. 3:133-143

AUGHEY, E., FELL, G.S., SCOTT, R., AND BLACK M. 1984. Histopathology of early effects of oral cadmium in the rat kidney. Environ. Health Perspect. 54:153-161

BIRGE, W.J., BLACK, J.A., WESTERMAN, A.G., SHORT, T.M., TAYLOR, S.B., and BRUSER, D.M. 1985. Recommendations on Numerical Values for Regulating Iron and Chloride Concentrations for the Purpose of Protecting Warmwater Species of Aquatic Life in the Commonwealth of Kentucky. Prepared for Kentucky Natural Resources and Environmental Protection Cabinet Under Memorandum of Agreement No. 5429. January 1985 (under review)

CALABRESE, E.J. 1983. Role of epidemiologic studies in deriving drinking water standards for metals. Environ. Health Perspect. 52:99-106

CAMP DRESSER & MCKEE INC. 1986. Final Interim Report, Milltown Site, Milltown, Montana.

CURTIS, W.L., 1984. Milltown Hydroelectric Project Engineering Evaluation. Montana Power Company, FERC Project No. 2543.

DOULL, J., KLAASSEN, C.D., and AMDUR, M.O., eds. 1980. Casarett and Doull's Toxicology: The Basic Science of Poisons. 2nd ed. Macmillan Publishing Co., New York. 778 pages

EISLER, R. 1977. Acute toxicities of selected heavy metals to the softshell clam, Mya arenaria. Bull. Environ. Contam. Toxicol. 17:137-145

ENTERLINE, P.E., and MARSH, G.M. 1982. Cancer among workers exposed to arsenic and other substances in a copper smelter. Am. J. Epidemiol. 116:895-911

FRIBERG, L.T., PISCATOR, M., NORDBERG, G. 1974. Cadmium in the Environment. 2nd ed. CRC Press, Cleveland

ISHINISHI, N., YAMAMOTO, A., NISANAGA, A., and INAMASU, T. 1983. Tumorigenicity of arsenic trioxide to the lungs in Syrian golden hamsters by intermittent installations. Cancer Lett. 21:141-147

LAYTON, D.W., ANSPAUGH, L.R., and O'BANION, K.D. 1983. health and Environmental Effects Document on Geothermal Energy. NTIS/DE82007889

LEE-FELDSTEIN, A. 1983. Arsenic and respiratory cancer in humans. Follow-up of copper smelter employees in Montana. JNCI 70:601-610

NATIONAL ACADEMY OF SCIENCES (NAS). 1973. Medical and Biological Effects of Environmental Pollutants: Manganese. Washington, D.C. 191 pages.

NATIONAL ACADEMY OF SCIENCES (NAS). 1977. Drinking Water and Health. Safe Drinking Water Committee, Washington, D.C. 939 pages

NATIONAL RESEARCH COUNCIL (NRC). 1980. Drinking Water and Health. Volume 3. National Academy Press, Washington, D.C. 415 pages

NATIONAL RESEARCH COUNCIL (NRC). 1982. Drinking Water and Health. Volume 4. Safe Drinking Water Committee. National Academy Press, Washington, D.C. 299 pages

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA). 1983. Occupational exposure to inorganic arsenic. FED. REG. 48:1864-1903

SCHILLING, R., ROSS, D., SOKAL, D., ING, R., BROKOPP, C., and MAUGHAN, A.D. 1984. Children's exposure to smelter-associated lead, Montana and Idaho. In the Procedings of the 5th National Conference on Management of Uncontrolled Hazardous Waste Sites. Washington, D.C. Novemebr 7-9, 1984

SHIRACHI, D.Y., JOHANSEN, M.G., McGOWAN, J.P., and TU, S.H. 1983. Tumorigenic effect of sodium arsenite in rat kidney. Proc. West Pharmacol. Soc 26:413-415

STOKINGER, H.E. 1981. The metals. In Clayton, G.D., and Clayton, F.E., eds. Patty's Industrial Hygiene and Toxicology. John Wiley and Sons, New York

TAKENAKA, S., OLDIGES, H., KONIG, H., HOCHRAINER, D., and OBERDORSTER, G. 1983. Carcinogenicity of cadmium chloride aerosols in W rats. JMCI 70:367-373

THUN, M.J., SCHMORE, T.M., SMITH, A.B., AND HALPERIN, W.E. 1984. Mortality among a cohort of U.S. cadmium production workers: An update. National Institute for Occupational Safety and Health, Washington, D.C. (unpublished)

TSENG, W.P., CHU, H.M., HOW, S.W., FONG, J.M., LIN, C.S., and YEH, S. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J. Natl. Cancer Inst. 40:453-463

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1976. Quality Criteria for Water. EPA 440/9-76-023. Washington, D.C.

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1980a. Ambient Water Quality Criteria for Arsenic. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C. October 1980. EPA 440/5-80-025

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1980b. Ambient Water Quality Criteria for Cadmium. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C. October 1980. EPA 440/5-80-025

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1980c. Ambient Water Quality Criteria for Copper. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C. October 1980. EPA 440/5-80-036

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1980d. Ambient Water Quality Criteria for Lead. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C. October 1980. EPA 440/5-80-057

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1980e. Ambient Water Quality Criteria for Zinc. Office of Water Quality and Standards, Criteria and Standards Division, Washington, D.C. October 1980. EPA 440/5-80-079

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1983a. Revised Section B of Ambient Water Quality Criteria for Arsenic. Aquatic Toxicology. August 19, 1983. Draft

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1983b. Revised Section B of Ambient Water Quality Criteria for Cadmium. Aquatic Toxicology. August 19, 1983. Draft

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1983c. Revised Section B of Ambient Water Quality Criteria for Copper. Aquatic Toxicology. August 19, 1983. Draft

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1983d. Revised Section B of Ambient Water Quality Criteria for Lead. Aquatic Toxicology. August 19, 1983. Draft

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1984a. Updated Mutagenicity and Carcinogenicity Assessment of Cadmium. (Review Draft). USEPA, Office of Health and Environmental Assessment. Washington, D.C. April 1984. EPA-600/8-83-0258

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1984b. Air Quality Criteria for Lead. Environmental Criteria and Assessment Office, Research Triangle Park, N.C., September 1984. EPA-600/8-83-028B, External Review Draft.

U. S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1985. STORET System Retrieval for CDM, Upper Clark Fork River Drainage, Retrieved by Richard Satirous, EPA Region VIII.

WOESSNER, W.W., J.M. Moore, C. Johns, M. Popoff, L. Sartor, M. Sullivan, 1984. Arsenic Source and Water Supply Remedial Action Study, Milltown, Montana. Department of Geology, University of Montana, Missoula, Montana, 448 pages.

APPENDIX B

DATA EVALUATION REPORT

MILLTOWN RESERVOIR SEDIMENTS
CERCLA SITE

DATA EVALUATION REPORT

MILLTOWN, MONTANA

MDHES Contract No.: 800454-TO-01

January 9, 1989

Document No.: 8469-RT-F-RO-010989

1.0 INTRODUCTION

This Data Evaluation Report has been prepared for the Montana Department of Health and Environmental Sciences (MDHES) by Camp Dresser & McKee Inc. (CDM) as part of Task Order No. 1 issued under Contract No. 800454. Several other activities were also initiated under this task order and include execution of seasonally constrained field work and project planning activities necessary to implement a downstream screening study, development of a feasibility study (FS) work plan, and validation of data previously collected at the site. This report supplements the FS Work Plan being prepared separately by CDM.

The purpose of this report is to evaluate the adequacy of existing data and identify additional data needs for the FS. Specific studies and field investigations needed to collect the additional data are also addressed. The specific objectives of this data evaluation are:

1. Conduct a review of all previous and ongoing studies to identify sources of data relevant to the Milltown FS.

2. List information and data requirements for completion of the FS, identifying the extent to which existing data may meet the requirements of the FS.

3. Identify the extent to which existing data may satisfy USEPA data quality objectives and data validation criteria.

4. Define additional data needs for completion of the FS.

2.0 REVIEW OF AVAILABLE DATA

Numerous environmental studies have been, or are currently being, performed in the Clark Fork River basin. For this Data Evaluation Report, these studies were reviewed for their applicability to the Milltown Reservoir Sediments FS in terms of providing information in the following areas of concern:

- o Ground Water
- o Surface Water
- o Sediment
- o Public Health
- o Environment (aquatic life, vegetation, wildlife, and wetland and floodplain assessment)

The following sections summarize those previous and on-going studies which provide required data relevant to the Milltown site. While not a complete list of all studies performed in the Clark Fork River basin, the studies discussed below represent a comprehensive discussion of those providing useful data in meeting the requirements of the FS.

2.1 SUMMARY OF PREVIOUS STUDIES

Previous studies in the Clark Fork River basin which may provide useful information in evaluating remedial alternatives for the Milltown site have been performed by the University of Montana, Harding Lawson Associates, the Montana Power Company, Montana Department of Health and Environmental Sciences - Water Quality Bureau (MDHES-WQB), the Montana Department of Fish, Wildlife, and Parks (MDFWP), the USGS, and others.

A reconnaissance-level study was conducted by Woessner and Popoff (1982) to identify contamination sources at the Milltown site. Existing wells were

monitored for water levels and ground water quality to identify the extent of apparent ground water contamination and the complex flow system. Included in the report are well log reports and water levels for 51 wells. Trace metal concentrations for 33 wells are reported, with two or more samples taken at 14 of these.

The remedial investigation study titled "Arsenic Source and Water Supply Remedial Action Study" by W. Woessner, J. Moore, C. Johns, M. Popoff, L. Sartor, and M. Sullivan (1984) was conducted to investigate sources of contamination to Milltown's water supply. This study along with the 1982 study discussed above constitutes the RI for the Milltown Reservoir Sediments site. Information from this report which may be useful in conducting the Feasibility Study include geophysical logs, ground water potentiometric maps, aquifer tests, and data on reservoir sediments including particle size distribution and sediment and pore water total and acid extractable metals chemistry. Surficial grab sampling and sediment coring occurred at 34 and 6 sites, respectively. Major cation/anion chemistry and metals chemistry were also characterized for select community wells in the Milltown area.

In 1983, CH2M Hill completed a "Remedial Action Master Plan" for Milltown, Montana to identify remedial investigation activities and remedial actions needed specifically to remedy the arsenic contamination problem in Milltown's water supply. Remedial actions were broken down into three types: initial, source control, and off-site remedial actions. The Remedial Action Master Plan provided preliminary cost estimates on proposed activities, estimates of data limitations, and community relations strategies.

Harding Lawson Associates (HLA) reported various data in their draft report entitled "Milltown Reservoir Data Report - Supplemental Investigations Conducted under the Feasibility Study" (1987). Subsurface sediments were sampled to provide information on the areal and vertical extent of contaminated sediments and the variability of sediment composition.

Twenty-four soil borings, located along six reservoir cross-sections, were completed within the fine-grained reservoir sediments. The borings were collected at regular sampling intervals, generally ranging from 2.0 - 2.5 feet to 25.0 - 25.5 feet, to the maximum depth of fine-grained sediments encountered in each boring and analyzed for selected trace metals. The volume of fine-grained sediments within the reservoir area was also calculated. Surface waters were sampled once in Spring 1985 and twice in Summer 1986. Grab samples (1985) and depth and flow integrated samples (1986) were collected at the USGS stations on the Clark Fork at Turah Bridge, the Blackfoot River near Bonner, and the Clark Fork River above Missoula, and on Milltown Reservoir near the boat ramp. The Spring 1985 samples were taken in conjunction with MDHES sampling to provide a quality control comparison. For both sampling episodes, analyses of total metals, dissolved metals, and suspended sediment concentrations were performed. Field parameters (including streamflow) were also measured. River bottom sediments were sampled once in Spring 1985 at each of the four stations and trace metals (total concentrations) analyzed. A simple mass balance was also performed to estimate sediment transport within the reservoir using data collected by MDHES-WQB.

In March 1986, HLA initiated a supplemental ground water investigation to complement existing ground water information. The objectives of this investigation were to provide additional ground water data for monitoring well locations sampled during the RI (Woessner, 1984), collect data from two new wells, and examine the speciation of aqueous arsenic in local ground water. Forty-six wells were sampled. Eighteen of these wells were selected for measurement of geochemical parameters and arsenic concentrations in key upgradient and downgradient locations. No domestic wells were sampled during this investigation. Field separation of arsenic species in ground water was determined by Ficklin's (1983) ion exchange method. Aqueous species of arsenic and the ratio of oxidation states of arsenic were also examined by use of the mineral/solution equilibrium model PHREEQE. Arsenic III and V oxidation ratios resulting from field separation of ground water samples and modeling show predominance of

arsenic (V) oxidation state in local ground water. Results are reported in the HLA draft report "Supplemental Ground Water Investigation Arsenic Speciation Milltown Reservoir CERCLA Site" (1987a).

MontPIRG interviewed 30 of a total of 36 residents in Milltown, Montana in April 1983 (MontPIRG, 1983) to assess water use history and health problems such as skin disorders, frequent colds, and respiratory problems all associated with ingestion and skin absorption of heavy metals. The medical survey consisted of a health questionnaire resembling a general medical history plus personal interviews. Interviewers ascertained the frequency, aggravation, and remedy of the symptoms. MontPIRG found that skin disorders and frequent colds were the "predominant" symptoms found in Milltown. The study did not include a control group.

Montana Power Company (MPC) prepared a report, the "Milltown Hydroelectric Project Engineering Evaluation" (Curtis, 1984), to investigate rehabilitation options for the Milltown dam. Information relevant to the Feasibility Study include sediment load-discharge ratings established for USGS stations at Turah Bridge on the Clark Fork and Wisherd Bridge on the Blackfoot, spillway rating curves, grain size distribution profile of reservoir sediments along the Clark Fork channel alignment, cross sections on the Blackfoot and Clark Fork channels, and frequency analysis of peak annual flows for the USGS station, Clark Fork above Missoula.

Potential water resource impacts resulting from the rehabilitation of Milltown Dam were investigated by Hydrometrics (1985) under contract with MPC. In this study, 10 test holes were drilled in the reservoir sediments and analyzed for particle size, total metals, EP toxicity, and distilled water extracts for metals. Detailed well logs are also included in the study report, as are transmissivity and permeability calculations.

In July 1985, MPC submitted an "Application for Amendment of License - Milltown Project No. 2543" before the Federal Energy Regulatory Commission (FERC). Contained in this application are discussions and summaries of

information relating to water resources, use, and quality (surface and ground waters); fish, wildlife, and botanical resources; historical and archaeological resources; socioeconomics of the area; geological and soil resources; recreation resources; aesthetic resources; and land use. Data presented in Appendix A to the Application include water quality data including flow, temperature, TSS, total recoverable metals, and other parameters sampled from March - December 1984; macroinvertebrate data at two locations on two separate occasions during 1984; and daily turbidity, total, total recoverable, and dissolved metals data collected during the 1981-1984 operational drawdowns. Appendix B of the application contains supplemental data regarding wildlife and botanical resources. Appendix E contains the recreation resources use and activities survey conducted for the application.

In support of its FERC application, MPC conducted a study titled "Milltown Reservoir and Clark Fork River Sedimentation Study" (Curtis, 1985). The purpose of the study was to evaluate the short and long-term effects that the proposed rehabilitation of the Milltown Project would have on the reservoir and river regimes. The study area was from the Higgins Street Bridge in Missoula to just upstream of Milltown Reservoir (a distance of 6.7 miles). The reservoir and stability of the river were evaluated using the HEC-6 computer model developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center. The simulation was performed using historical streamflows for the period 1935-1948 (14 years). Topographic and hydrographic surveys of the dam site and project lands were conducted, although the results are not presented in the report. Streamflows, suspended sediment load, and streambed and reservoir bed samples were also taken. A frequency analysis of annual peak streamflows was performed for the period 1929-1981. Sediment load rating curves were developed and presented for the Clark Fork at Turah, the Blackfoot at Wisherd Bridge, and the Clark Fork below Milltown Dam. Bed material gradation curves are presented for all cross-sections modeled along the study reach.

MPC has also collected water quality samples during Phase I of the Milltown dam rehabilitation. These data were collected at three locations--Clark Fork River at Turah Bridge, Blackfoot River near Bonner, and Clark Fork River above Missoula. Data are available for the period September 21, 1986 to April 4, 1987. These data include weekly flow measurements with analyses of total recoverable and dissolved metals, and twice-weekly (including daily for two weeks) flow measurements with analyses of acid soluble metals using grab sampling techniques. Other measurements included turbidity, dissolved oxygen, pH, temperature, and total hardness. One-time sediment sampling was also performed in November and December 1984 for analyses of metals by total digestion, EP toxicity, and particle size distribution.

The MDHES-Water Quality Bureau (WQB) conducted a monitoring program on the Lower Clark Fork River from Turah downstream to the Idaho border for the renewal of Champion International's Waste Water Discharge Permit. The reports titled "Champion International Frenchtown Mill Discharge Permit MT-0000035: Data Report Volumes I and II" (1985) were prepared by Gary L. Ingman for MDHES and present data collected in 1984 and 1985 by MDHES and MDFWP. Volume I of the Data Report tabulates results of water quality monitoring at 31 stations over the 225 mile stretch of river. Stations of interest to the Feasibility Study are upstream of the Milltown reservoir at USGS locations on the Clark Fork and Blackfoot Rivers, downstream of the reservoir at USGS stations above Missoula and one station within the Milltown reservoir. River and reservoir water samples were collected either biweekly, monthly or seasonally from March 1984 to August 1985 and analyzed for field parameters, total recoverable and/or acid soluble and dissolved metals, nutrients, total suspended solids,and hardness as well as other parameters. Bottom sediment samples were collected in the Milltown reservoir and analyzed for total and total recoverable metals. Volume II of the Data Report is a collection of reports presenting findings of special studies conducted for the Water Quality Bureau. Of interest to the Feasibility Study are algal bioassays to determine nutrient limitations and metals toxicity, chronic bioassays using juvenile rainbow trout and

Ceriodaphnia, trout and macroinvertebrate censuses, and metals concentrations, particularly copper, in crayfish. All studies contained a sampling point downstream of the Milltown Reservoir.

A fishery study titled "Middle Clark Fork River Fishery Monitoring Study" (1985) found as part of the Champion International Frenchtown Mill Discharge Permit: Data Report Volume II, was conducted by MDFWP to determine numbers, species composition, and condition of fish populations from Milltown Dam downstream to the Flathead River. Data on trout egg and fry survival and toxic metals concentrations in crayfish exoskeletons, as an indicator of metal stress were also reported. The above were reported to determine the exposure regime and to identify factors contributing to the absence of brown trout below Missoula.

A study of metal concentration in the Upper Clark Fork River floodplain at the Grant-Kohrs ranch was conducted by P. Rice and G. Ray (1985) and presented in the Clark Fork River Symposium. One-time sampling of floodplain sediments was performed in July 1983 and analyzed for total metal concentrations. Copper, arsenic, and cadmium concentrations were also analyzed in vegetation samples. Of interest to the Feasibility Study are soil and vegetation data for uncontaminated, control areas.

In a study of relationships among fish populations, metals concentrations, and stream discharge in the Upper Clark Fork River, by G. Phillips (1985), weekly streamflow samples were taken from April through July 1984 and analyzed for total copper, iron, and zinc concentrations. Following natural fish kills, gill tissues from brown trout were analyzed for copper and cadmium metals residue. This study was presented as part of the Clark Fork River Symposium.

A study was conducted in 1985 by Carolyn Johns and Johnnie Moore to determine heavy metal contamination in reservoir sediments downstream from Milltown Reservoir. The objective of the study was to evaluate the extent of heavy metal contamination in the lower drainage, given that Milltown

Reservoir has trapped a large part of the sediments. The reservoirs sampled were Noxon Rapids, Thompson Falls, and Cabinet Gorge Reservoirs on the Clark Fork River (existing data from Milltown Reservoir, reported in Woessner, et al. (1984), were also utilized in the study). Samples collection included 3-37 grab samples and 3-6 cores (up to 45 cm in depth) from the reservoir sediments, with analyses for total and/or acetic acid extractable copper, arsenic, and zinc. Cores from 2 of the reservoirs were also collected to assess vertical variation in metal concentrations of the sediment. Grain size distributions of the sediments are included in the report. This study was also presented in the Clark Fork River Symposium and can be found as part of the "Champion International Frenchtown Mill Discharge Permit Data Report: Volume II" (1985).

A study by J. Moore, W. Ficklin, and C. Johns (currently in press, Environmental Science and Technology) titled "Partitioning of Arsenic and Metals in Reducing Sulfidic Sediments" was performed to study the processes in Milltown Reservoir that fix trace elements in the sediment and release arsenic and manganese to ground water. One core sample from a site located close to the contaminated water supply wells at Milltown was taken and analyzed over a 120 cm depth for stratigraphy, grain size distribution, pH, and trace metals concentrations. Results are reported graphically.

Streambank sediment sampling was performed by an EPA REM/FIT subcontractor, Ecology and Environment, at 38 sites on tributaries to and along the mainstem of the Clark Fork River between Warm Springs and Milltown to identify the source of metals contamination at the Milltown Reservoir. Results are reported in "Source of Metal Contamination in Milltown Reservoir, Montana" by J. Moore (1985b). One time samples were collected in April 1985 and analyzed for total and acid extractable arsenic, copper, lead, cadmium, manganese, iron and aluminum concentrations as well as for carbon content and particle size distribution.

Several studies have also been conducted by graduate students at the University of Montana under the direction of Dr. Johnny Moore, Dr. William

Woessner, and Dr. Vicki Watson. These studies were reviewed for their applicability and as sources of data for the feasibility study. The studies which pertain to the Milltown site are summarized below:

- A project by Steve Mehring studied the November 1983 to February 1984 drawdown which involved a five-foot total drop in the headwater elevation. An upstream and a downstream station on the Clark Fork River were monitored during the drawdown period. Depth-integrated grab samples were collected at these two stations and analyzed for pH, total suspended sediments, arsenic, cadmium, and copper. Results from the study show that total suspended sediments and total recoverable arsenic and copper concentrations increased significantly from the upstream site to the downstream site below the dam during the drawdown. However, arsenic and copper in suspended sediments (expressed in ug/g sediment) were not significantly different at the two stations. The study is described fully in the unpublished Master's thesis by Mehring (1985).

- A project by Ed Brook examined the distribution and particle-size control of metals in bed sediment from 26 locations along the upper Clark Fork River. A total of 31 sediment samples were collected in the spring and summer of 1986. Distributions of cadmium, copper, iron, manganese, nickel, and zinc by grain-size were reported. Results from the study showed no significant correlations between fine-grained sediments (<63 μm size) and bulk metal concentrations. The results are summarized in a paper (Brooke and Moore, undated) submitted to Water Research. A similar study was performed using 1985 EPA sampling and analyses (Moore, Brook, and Johns, undated) in a paper submitted to Environmental Geology and Water Sciences (in press).

John Lambing (1987) of the USGS conducted a water quality sampling program at six sites on the Clark Fork River and selected tributaries from Deer Lodge to Milltown. Suspended sediment and trace metal concentrations were analyzed. Cross-sectional, depth-integrated samples for suspended sediment and trace metals were collected periodically from March 1985 through May 1986; daily mean streamflow and fixed-point suspended sediment sampling was performed from March 1985 through June 1986 at two mainstem gaging stations. Sampling frequencies were dependent on flow conditions, with daily collections during medium and high flows and approximately every other day during low flows; the number of sampling episodes varied from 6 to 12 depending on the gaging station. Instantaneous streamflows at the time of sampling was determined at all sites. Trace metals analyses

included total and dissolved arsenic; total recoverable and dissolved cadmium, copper, iron, lead, and manganese; and dissolved zinc. Suspended sediment samples were analyzed for concentration and particle size (percent finer than 62 microns). Graphical presentations include: metals concentrations and statistical distributions of suspended sediment; relationships between metals and suspended sediment concentrations, and concentrations of metals in suspended sediment; and hydrographs of daily mean streamflow and suspended sediment, and daily mean suspended sediment discharge.

Additional data collected by the USGS along the Clark Fork are reported in their annual reports, "Water Resources Data for Montana." These data may also be found in the USGS WATSTORE database and includes sampling and analysis results for streamflows, total and dissolved metals, suspended sediment concentrations and particle size distributions, and other water quality parameters (reported results vary by gaging stations). These data are available for numerous stations in the Clark Fork River basin between Butte and the Idaho border sampled over the years 1898 to the present with periods of record ranging from 5 up to 55 years.

Metals concentrations for samples collected under the National Uranium Resource Evaluation (NURE) program are reported by Braxton (1980) in "Uranium Hydrogeochemical and Stream Sediment Reconnaissance Data Release for the Butte NTMS Quadrangle, Montana, Including Concentrations of Forty-Two Additional Elements." During 1976-1977, 1,370 surface water samples and 1,951 sediment samples were collected from 1,944 locations in the Butte quadrangle, including sites in the Clark Fork River basin from its headwaters to Missoula. Uranium, pH, water temperature, and conductivity measurements are reported for the surface water samples. Reported sediment sampling results include uranium and other elemental concentrations, including cadmium, copper, iron, lead, magnesium, manganese, nickel, potassium, silver, sodium, zinc, gold, and silver.

A STORET data search was performed by CDM (USEPA, 1985b) which provided some surface water quality data both upstream and downstream of the Milltown Dam. Streamflows, total and dissolved metals, suspended sediment, and numerous other water quality parameters were reported for gaging stations throughout the Clark Fork River basin. The data indicated that the total metal concentration downstream of the dam are elevated when compared to concentrations just upstream of the sediments in the reservoir (Clark Fork River at Turah) or in the the Blackfoot River. However, dissolved metal concentrations are approximately the same upstream and downstream of the dam.

In a report by Max H. Dodson and Del Wayne R. Nimmo (USEPA) et al. titled "Three Case Studies on the Use of Ceriodaphnia as Indicators of Water Quality in Western Trout Streams" (undated), biomonitoring was used to identify areas of toxicity along the Upper Clark Fork River from its headwaters to Turah above Milltown. Acute and chronic toxicity tests were performed with Ceriodaphnia between May 16 and May 22, 1985 using grab water samples at each sample location.

An evaluation of aquatic toxicity was conducted in May 1985 at several sampling locations from Butte to below the Missoula Sewage Treatment Plant on the Clark Fork River. Results are reported in "Relationship of Microbial Activity and Ceriodaphnia Responses to Mining Impacts on the Clark Fork River, Montana" by G.A. Burton, A. Drotar, J.M. Lazorchak, and L.L. Bahls, in "Archives of Environmental Contamination and Toxicology," Volume 16, pages 523-530, 1987. The battery of tests included the 7-day Ceriodaphnia survival-reproduction assay and 12 microbial assays of enzyme activity, heterotrophic uptake and metal resistance to arsenic, copper, and selenium in sediment and/or water samples. Stream measurements included diatom species number and diversity and for sediments, total recoverable arsenic, copper, and selenium concentrations.

The distribution of fine-grained bed sediment and associated metals on the Clark Fork River between Warm Springs Creek and the Flathead River is

presented in the E.D. Andrews publication, "Longitudinal Dispersion of Trace Metals in the Clark Fork River, Montana" (1986) as part of a symposium entitled "Chemical Quality of Water and the Hydrologic Cycle" edited by R.C. Averett and D.M. McKnight. Fine-grained bed materials were sampled from 12 locations on the mainstem and on 5 tributary streams, samples divided according to grain size, and the size fractions analyzed for total and partially digested arsenic, cadmium, copper, lead, zinc, aluminum, iron, and manganese. Metals concentrations were correlated with sediment size in several cases and with distance downstream of Warm Springs Creek.

The Montana Fish and Game Department (now MDFWP), Fisheries Division monitored a March 27, 1970 drawdown from the Milltown Dam reported in "Inventory of Waters of the Project Area," Report No. F-12-R-17, Job No. Ia (Marcoux, 1970). Daily water quality samples were obtained 300 yards and 5 miles below the Milltown dam for two weeks following drawdown and analyzed for zinc, iron, copper, and turbidity. It was not indicated whether metal concentrations reported were total, total recoverable, or dissolved. Caged adult and fingerling hatchery rainbow trout were introduced to the river 0.5 and 5 miles below, and on the Blackfoot River 3 miles upstream of Milltown Dam, and mortality counts noted. Data are inconclusive because the trout were introduced to the river after the peak in metals and turbidity and when concentrations of these parameters were the same at both downstream sampling locations. Also, hatchery trout were not acclimatized to river conditions prior to the study and the number of trout was not consistent at each sampling location.

The MDFWP, Fisheries Department inventoried the Clark Fork at Turah and below Milltown Dam, and the Blackfoot and Bitterroot Rivers in 1979 and 1980 for fish number, size, and species composition. Mark and recapture techniques were employed to estimate growth rates and age composition of trout. Results are tabulated in "Inventory and Survey of the Lower Clark Fork, Blackfoot, and Bitterroot Rivers," Project No. F-12-R-27, Job Ib (Peters, 1981).

Results of annual fish inventories between 1980 and 1984 on the Clark Fork and Blackfoot Rivers are reported by the Montana Department of Fish, Wildlife and Parks, Fisheries Department in the job progress report "Inventory and Survey of the Lower Clark Fork, Blackfoot, and Bitterroot Rivers," Project No. F-12-R-31 Job Ib (Peters, 1985). Parameters included fish size, number, and species. Snorkel and mask count techniques were compared to electrofishing sampling techniques on the Bitterroot River where water conductivity limits the use of electrofishing. Data for determining minimum instream flows using the wetted perimeter technique for several tributaries including Fish Creek, Trout Creek, Cedar Creek, Petty Creek, Daly Creek, Roaring Lion Creek, Canyon Creek, and Sweathouse Creek are filed in Region 2 fisheries files.

Minimum instream flows for beneficial use for fish and wildlife and recreational uses on the Upper Clark Fork were determined in "Application for Reservations of Water in the Upper Clark Fork River Basin" (MDFWP, 1986) based on two criteria: (1) flows necessary for physical fish habitat quality, and (2) tributary flows needed to maintain the existing water quality in the Clark Fork River. The former was derived using the Wetted Perimeter Inflection Point method (Nelson, 1983) and the latter based on water quality data from the Upper Clark Fork and water quality standards and criteria. Extensive supporting data, largely compiled from other sources include streamflows, copper concentration and loading, measurements of dissolved oxygen and water temperature, and inventories of dissolved oxygen and water temperature, and inventories of irrigated land, permits for industrial discharge and public water supplies. The report noted that an increase in copper concentrations occurred during higher flows due to flooding of streambeds and floodplains containing tailings redeposited there after erosion from mining areas.

Chemical analyses were completed on tissues taken from Canada Geese and Common Mergansers and on whole bodies of shorebirds, fish, and aquatic insects collected from pool areas of Milltown Reservoir known to contain

contaminated sediments. Samples were analyzed for cadmium, arsenic, selenium, mercury, copper, zinc, and lead by the USFWS. Data are reported in the "Interim Report - Preliminary Analysis of Milltown Biological Samples" (Wood, 1986), a document sent to the Environmental Protection Agency, attn. Jim Knoy. The final report issued by the Division of Fish and Wildlife Enhancement (USFWS) in May 1988 contains the results of 14 fish, 3 plants, 1 aquatic invertabrate, and 72 bird tissue analyses. The fish, invertabrate and plant samples showed small concentrations of some heavy metals, but none at levels of concern except possibly for zinc in the plant samples. Elevated levels of at least one constituent were observed in at least one bird for all except arsenic and copper. None were detected at unusually high levels except for zinc in one Canada Goose gosling. The source of the contaminants could not be identified. The report concluded that the data do not demonstrate that a major contamination problem exists but concern remains due to the elevated levels found. Additional limited investigations were recommended.

A recreational use survey of the Upper Clark Fork and its tributaries was conducted by the Wilderness Institute of the University of Montana (Hagman, 1979). Recreational use of the river was noted by field reconnaissance, overflights, and questionnaires. Fishing was the primary recreational activity with recreational vehicle camping also popular. The most concentrated use along the river occurred at designated campgrounds, but heavy use also occurred in areas with good vehicle access including the Milltown Reservoir at the railroad crossing bridge.

Estimates of the recreational value of the Upper Clark Fork River are provided in a study by Dr. John Duffield (1984). These are updated from a previous study also by the author which was completed in 1981, using the travel cost methodology described in the 1981 document. The study concluded that in 1984 the net worth of the Upper Clark Fork was $7.5-11.5 million dollars. The estimates were believed to be conservative and could be higher by as much as a factor of 10.

References to other past investigations potentially useful for conduct of the FS have been identified, but have not as yet been located to verify and evaluate available data. These studies are as follows:

A study regarding heavy metals in sediments in the Milltown Reservoir was reported by the Montana University Joint Water Research Resource Council (1976).

A report by Peters attached to a job progress report by Glenn Phillips (1982) of MDFWP, discussed a trout survey that indicates possible effects of the Milltown sediments on fish populations below the dam.

Aquatic insects were sampled in 1984 and 1985 by the USGS to determine trace metal accumulation in the insect population along the Clark Fork. The study was coordinated with the previously described USGS study of sediments and metals.

2.2 ONGOING STUDIES

A number of studies are currently being performed in Clark Fork River basin which should be of use in evaluating remedial alternatives.

An ongoing thesis project by Ann Udaloy of the University of Montana involves the study of sediments and water in the Milltown Reservoir during the Phase I Milltown dam rehabilitation (Woessner and Moore, 1988). Monitoring wells have been installed in a grid pattern to measure and model the direction and rate of ground water flows. Monthly samples have been taken from August 1986 through September 1987. The objective of the study is to measure changes in speciation of metals between reduced and oxidized zones within the reservoir sediments. It was found that the stratigraphy of the sediments differed significantly between monitoring locations, making characterization difficult. Strong downward gradients also exist in the reservoir sediments under all reservoir water surface level conditions examined. The results of this project have just recently been published in

"Arsenic Mobilization in Response to the Draining and Filling of the Reservoir at Milltown, Montana" (Udaloy, 1988).

Under the leadership of Vicki Watson, University of Montana, a study has been proposed to investigate heavy metals sources and sinks throughout the Clark Fork River system, analyze the role of river reservoirs in the retention of heavy metals, and investigate the interaction between organic matter and nutrient loading and the bioavailability of metals in the sediments (Johnson, 1987). Sampling results from the USGS studies and other University studies will be used.

As part of their Clark Fork Basin Water Quality Monitoring Project, the MDHES-WQB has been collecting water quality information at more than 30 fixed stations in the basin since 1985. Eighteen of these stations are located below Rock Creek and include paired stations above and below Milltown Reservoir. Samples for chemical and physical parameters are collected approximately 16 times per year--monthly from August-March, and twice monthly from April-July. Biological samples (quantitative macroinvertebrates samples, qualitative periphyton samples) are collected once each year, in August. Chemical/physical parameters include: streamflow, water temperature, pH, alkalinity, water hardness, total recoverable copper, zinc and arsenic, total Kjeldahl nitrogen, total phosphorus, dissolved nitrate plus nitrite, dissolved orthophosphorus, dissolved ammonia, total suspended sediment and volatile suspended sediment. The program is currently projected to continue through June 1991.

Dennis Workman at the MDFWP indicated that evaluation of optimal instream flows on the Clark Fork downstream of Milltown Dam would start in the near future (Workman, 1988).

A publication by MDFWP on recruitment within the trout population will be available in August 1988 (1988). Trout populations decrease below Milltown Dam possibly because of a scarcity of adequate spawning areas. Most of the

good quality spawning areas are located in tributaries upstream of the reservoir which are inaccessible to downstream fish populations.

Don Peters of the MDFWP indicated that Glenn Phillips had designed a continuous feed cage for trout for work on the Upper Clark Fork River (Peters, 1988). Rod Berg will be using this apparatus for trout bioassays downstream of Milltown Dam. Information on study design and timing is not currently available.

A study of the Blackfoot River system was to be initiated by the MDHES in the summer of 1988 in response to public concern over an apparently declining fishery resource (MDHES, 1988). The purpose of the study is to determine if there is a water quality basis for the decline. It will consist of chronic toxicity bioassays, macroinvertabrate surveys, testing of ambient water quality and possibly screening for priority pollutants at 14 locations. The water quality analyses will consist of determination for major cations/anions, heavy metals, and various physical parameters. Sampling will be conducted in the summer of 1988 and spring of 1989.

As part of Task Order No. 1 issued under Contract No. 800454 with CDM, two monitoring efforts are currently underway to determine the potential impacts of the Milltown Reservoir site. The first monitoring effort is the Downstream Screening Study which is being conducted to perform an initial screening for identification of potential contamination downstream of Milltown Dam. The second effort involves the collection of surface water data necessary for completion of the FS. Monitoring activities under the second program is presently limited to the collection of data corresponding to specific time-constrained flow events. Due to the MPC drawdown that began on June 27, 1988 for powerhouse rehabilitation, both sampling efforts were initiated in order to collect water quality data prior to and during the drawdown event.

Activities currently being performed under the Downstream Screening Study involve water quality sampling at seven locations on the Clark Fork, from

the USGS gaging station at Turah to the Shuffields site downstream of Milltown. Sampling locations were chosen to coincide with USGS gaging stations and locations used by the MDHES-WQB in their monitoring programs. Individual, one-time, grab samples are being taken. Total, total recoverable, and dissolved metals, major ions, TSS, pH, DO, temperature, and conductivity will be analyzed and/or measured.

During the reservoir drawdown, daily single-point depth-integrated surface water sampling is also being conducted by the USGS and MPC's consultant at two upstream sites (Blackfoot River at Bonner and Clark Fork River at Turah) and one downstream site (USGS gaging station at East Missoula). Sample splits are being obtained by CDM immediately after collection for separate CLP lab analyses to confirm USGS/MPC analyses. In addition, the USGS will conduct two detailed sampling episodes at these stations, one just prior to initiation of reservoir drawdown and the other just prior to completion of drawdown; cross-sectional, depth-integrated samples will be collected to check single-point samples collected by the MPC sampling team. Total, total recoverable, and dissolved metals, major ions, TSS, pH, DO, temperature, and conductivity will be analyzed and/or measured. One representative streambed sediment sample at each USGS station will also be obtained by the USGS. The sediment samples will be analyzed by CLP for grain-size distribution; total and total recoverable metals concentrations will also be determined for the sediments partitioned into <63 and >63 microns size fractions.

Also as part of the monitoring activities under the Downstream Screening Study in Task Order No. 1, ground water monitoring will be conducted, consisting of water level measurements taken from 10 wells with the study area between Hellgate Canyon and Milltown Dam. The measurements will be taken during high and low ground water periods (late June and mid-August, respectively).

Additional sampling of surface and ground water and bed sediments is also planned as a part of the Downstream Screening Study. Data gathered during these investigations will allow:

- o characterization of surface water quality in the mainstem of the Clark Fork River below Milltown Reservoir;
- o determination of impacts to aquatic life downstream of Milltown Dam;
- o characterization of alluvial ground water quality downgradient of the reservoir;
- o quantification of heavy metals concentrations in river sediments within the study area; and
- o identification of major irrigators within the study area and any associated heavy metals soils contamination.

Where appropriate, ongoing and future activities under the Downstream Screening Study which will provide information necessary for completion of the FS are identified in Section 3.0 of this report.

3.0 INFORMATION AND DATA NEEDS FOR EVALUATION OF FEASIBILITY STUDY ALTERNATIVES

A potential range of remedial alternatives have been identified for further evaluation based on recommendations made in the CDM Interim Report, HLA's Draft FS, and reviews of applicable technologies for other Superfund sites. Additional concerns have also been identified which should be specifically addressed in the FS. This section summarizes the remedial alternatives and additional concerns and defines information and data needs to evaluate these during the FS. The technical adequacy of information available to meet these needs is discussed. Finally, information gaps are identified and recommendations for additional data gathering and/or sampling are made to confirm or augment the available information.

3.1 SUMMARY OF REMEDIAL ACTION ALTERNATIVES AND SPECIAL CONSIDERATIONS

A preliminary list of remedial action alternatives was prepared by CDM during the FS Work Plan development under Task Order No. 1 to provide a basis for developing information needs. At this stage, the alternatives are not formulated to address all pathways and do not necessarily provide a comprehensive definition of applicable technologies. These alternatives will be reformulated during the Feasibility Study to address specific pathways for an operable unit or appropriate combinations developed to address all pathways and receptors.

The selected remedial alternative must be protective of human health and the environment and attain applicable, relevant, and appropriate requirements (ARARs). Protectiveness is determined based upon a public health evaluation and environmental assessment, discussed in Section 3.5 and 3.6, respectively.

Summary descriptions of eleven remedial alternatives selected during the preliminary screening are provided below.

1. **No Action**
   There will be no remedial action taken under this alternative in addition to construction of the alternate water supply system. This alternative will provide the baseline conditions against which the other alternatives will be evaluated. Assessment of public health and environmental risks for this alternative must assume no institutional controls (dam operations; ground water, surface water, and land use) beyond those currently in existence. CDM has assumed that proposed dam rehabilitation efforts will be completed. Monitoring is not considered part of the no action alternative.

2. **Institutional Controls**
   This alternative requires the establishment and enforcement of specific ground water, surface water, and land use restrictions; dam operation restrictions; and maintenance of a comprehensive monitoring program. The primary mechanism of ensuring these institutional controls would be through local ordinances. There would be restrictions placed on well construction within the present and future extent of the ground water plume and alternative water supplies would be provided to affected water users. Surface water and land use restrictions would involve limitations to site access, recreational uses (boating, fishing, etc.) and new dwellings or structures. Restrictions on dam operations with respect to the frequency, rate and depth of reservoir drawdown would be imposed to minimize resuspension and downstream transport of contaminated sediments.

3. **Removal and Disposal of Sediments (without treatment)**
   This alternative involves the complete removal of all contaminated sediments and disposal in a RCRA (or other appropriate) facility or in a regional waste repository. Removal would be achieved through hydraulic and/or mechanical dredging. The river would be diverted temporarily to allow excavation activities to take place. Excavated sediments could be transported to the disposal site via a slurry pipeline or dried and transported in trucks or by conveyor. Dewatering of the sediments can be accomplished through on-site drying beds or extraction, in which case the water may have to be treated prior to discharge.

4. **Removal, Treatment, and Disposal of Sediments**
   This alternative involves the complete removal of contaminated sediments, on-site or off-site treatment, and disposal in a non-RCRA type facility. The difference between this and Alternative 2 is the on-site or off-site chemical treatment of sediments. Treatment of the excavated sediments can be achieved through solidification processes (cement or non-cement such as fly ash) or chemical reprocessing. Depending on the kind of fixation

agent used, dewatering of the sediments may be necessary before treatment. The resulting water may require treatment prior to discharge.

5. **Sediments Flushing/Stabilization**
   This alternative involves injecting clean water or fluids into the sediments to flush or prevent leaching of contaminants via a series of injection wells or infiltration galleries. The placement of the wells would be such as to minimize impact on the existing clean water supplies.

6. **In-Situ Treatment**
   This alternative involves construction of an injection system within the reservoir sediments to perform a variety of in-situ treatments such as chemical injection, and other new technologies. Chemicals and/or other fixation agents will be injected through a series of well points. The range of chemicals available to perform chemical treatment include oxidizing or reducing agents to prevent or enhance leaching. Bench-scale treatability studies would be required to determine the most effective treatment technology.

7. **Reservoir Sediment and Channel Stabilization**
   This alternative may involve covering, capping, sealing, or grouting of the reservoir sediments and armoring of the channel. Temporary diversion of the river channel would be required. Partial removal and dewatering of the fine-grained sediments may be required prior to placing the cap. The cap material could be either asphalt, concrete, soil cement, chemical sealants, synthetic membranes, or a combination. Sealants and grouts may be either injected or used as a covering. Methods for grouting and sealing include hydraulic isolation followed by grouting, in situ covering and sealing, and in situ injection. The concept of sediment stabilization may include such temporary measures as excavation during periods when the sediments are frozen to minimize risks of resuspension of contaminated sediments.

8. **Source Control**
   This alternative involves the construction of a by-pass channel to isolate the Clark Fork River from the reservoir sediments. Control of sediment loadings to the system above Milltown Reservoir will be considered within the scope of the Silver Bow Creek and Anaconda Smelter NPL sites but outside the scope of the remedial action for the Milltown Reservoir Sediments site. The by-pass channel could be lined to provide scour protection during high flows.

9. **Containment of Contaminated Ground Water**
   This alternative involves the use of physical and/or hydraulic barriers to restrict the migration of contaminated ground water from the reservoir sediments. Physical barriers would consist of soil-bentonite slurry, grout curtains, or sheet-pile cutoff walls.

The wall would be keyed into impermeable materials at the base and sides. The hydraulic barrier would consist of a series of injection wells, seepage basins, or infiltration galleries that would create a ground water gradient sufficient to contain the contaminated ground water from the reservoir sediments. The size and placement of the hydraulic and/or physical barrier would be such as to minimize any impact to existing clean water supplies.

10. **Ground Water Extraction and Treatment**
This alternative involves placing a series of pumping wells within the sediments and/or downgradient wells and treating the pumped water prior to discharge into the river. If the wells are placed within the sediments, the low permeability of the sediments will require closely spaced, vacuum-operated well points. An option would be to place pumping wells within the alluvial aquifer underlying the sediments. Downgradient wells can be constructed with a fully screened interval within the saturated portion of the alluvial aquifer. A treatment plant/system would be constructed on-site to treat the water.

11. **Dam Engineering**
This alternative consists of two options: (1) complete removal of the dam, and (2) raising the sluiceway and the dam crest. Complete dam removal will involve cofferdamming and removing portions of the dam in sequence. To some extent, the rehabilitation of the dam by Montana Power Company has accomplished the second subalternative, i.e. the maximum reservoir stage has been elevated and the capacity of the reservoir to accumulate sediment has been increased.

Two general operating assumptions apply to the above list of alternatives. First, it was assumed that timing of remedial actions may be designed to coincide with completion of upstream remedial actions that would provide source control for surface water inputs to the Milltown system. Second, the FS is expected to produce combinations of these concepts and further definition of applicable technologies that would provide suitable protectiveness regarding all media and all receptors. The intent in developing the above list is to present a range of remedial alternative technologies that will allow anticipation of the relevance of specific ARARs and to most appropriately define information requirements.

It has also been assumed that the remedial alternatives, as packaged in the FS as balanced remedies, would be subject to evaluations of at least the

following contingencies: (1) the occurrence of a 100-year flood event, and (2) the partial and significant failure of upstream sediment control measures.

Based on internal CDM discussions and MDHES comments, the following additional concerns should be specifically addressed in Work Plan preparation and the conduct of the FS:

- o Determination of the existence and extent of a contaminated ground water plume downstream and northwest of the Milltown Dam;
- o Determination of potential impacts of the remedial alternatives relative to the Missoula sole source aquifer;
- o Definition of the full range of reservoir management options that would be relevant to contaminant releases;
- o Evaluation of potential contamination of the replacement water supply well by organic contaminants as well as by arsenic and metals;
- o Development of a suitable Endangerment Assessment approach that recognizes the spatial limits of the Milltown cleanup and the source control obtainable through Milltown remedies;
- o Development of an EA element of the Work Plan that may be separated from the FS, retaining the option of independent completion of the EA;
- o Delayed development of the Health and Safety Plan corresponding to the Work Plan pending decisions regarding PRP, DHES, or EPA lead on the work;
- o An evaluation of the efficacy of Montana Power Co. sediment disposal ponds located southeast of Milltown Dam; and
- o An evaluation of other potential disposal sites for Milltown sediments.

These concerns may generate information requirements for the FS beyond the requirements of alternative development and evaluation; such information requirements are identified in the following sections.

3.2 GROUND WATER

Technical evaluation of the various remedial alternatives summarized in Section 3.1 will require baseline ground water information for the no action alternative against which the other alternatives will be evaluated. This information is necessary to define the conceptual model of ground water contamination at the Milltown site. Conceptual definitions will then be extended to models that can be used to assess the effects of various remedial alternatives on ground water quality and quantity. A preliminary evaluation of models available to assess ground water effects at the Milltown site is included in the FS Work Plan Section 5.0. Additional information will also be required to evaluate the feasibility of ground water extraction/treatment and containment alternatives (Alternatives 9 and 10). Generally, information required will include the following:

- o Identification and characterization of sources and major contaminants of concern.
- o Delineation of the areal and vertical extent of ground water contamination.
- o Hydrogeologic and geochemical characteristics of the alluvial aquifer including recharge from the reservoir sediments.
- o Characterization of the recharge/discharge relationship between contaminated ground water and the surface water of the lower Clark Fork River.
- o Identification of potential receptors and well users.
- o Characterization of background ground water quality.

The adequacy of existing ground water data to meet information needs in each of the above categories is described below.

3.2.1 SOURCE CHARACTERIZATION

The Remedial Investigation for the site has adequately defined the reservoir sediments as the major source of arsenic and metals contamination

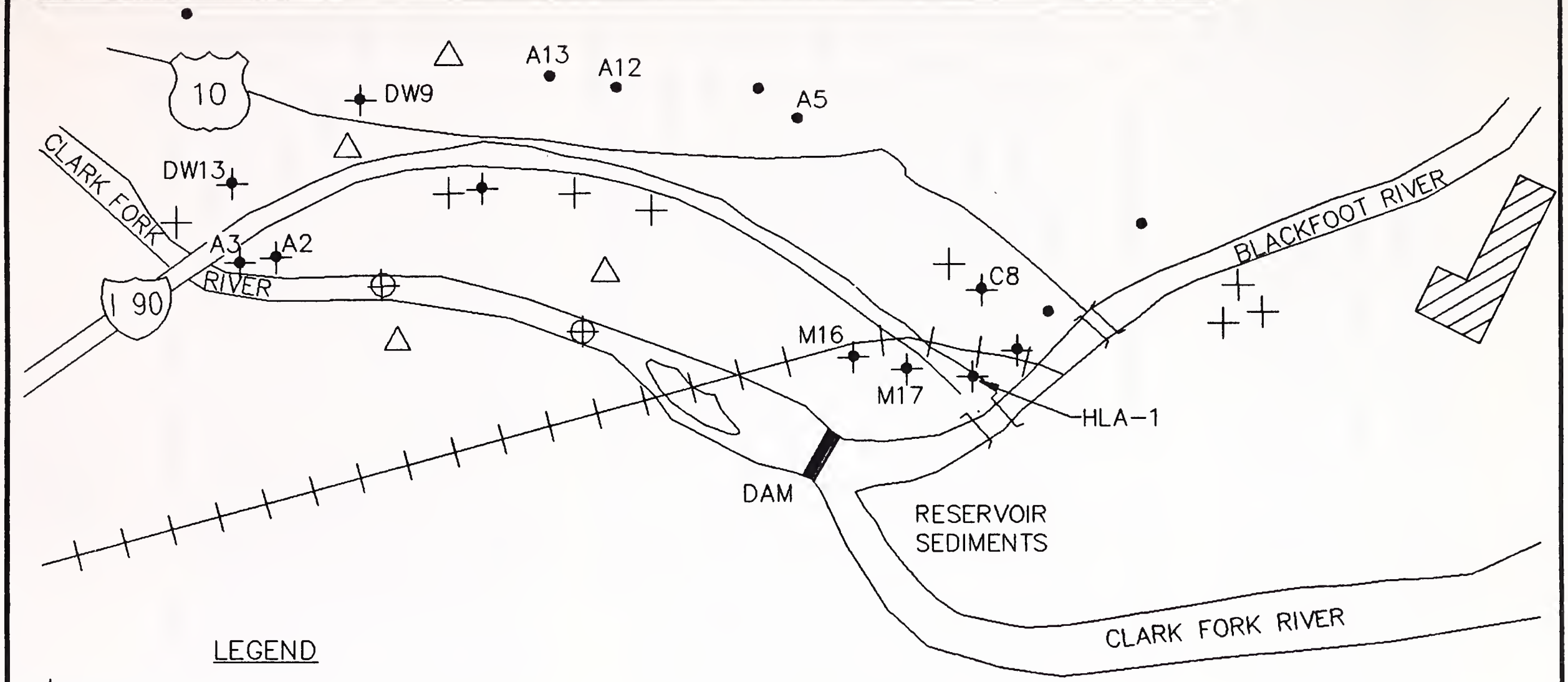
in the ground water. Flow paths and contaminant concentration gradients have been clearly established as originating from the reservoir sediments based on water level and water quality data provided in the RI report (Woessner et al., 1984) for the period February 1982 through June 1984. Similar conclusions can be made using ground water data gathered by HLA (1987) during their supplemental field investigations. Although the HLA (1987) data has not undergone data validation, data from the RI has been validated and is adequate for source characterization.

As previously stated in Section 3.1, an additional concern that has been identified and should be addressed during the FS is the potential contamination of the Milltown replacement water supply well by organics. Also, potential impacts of the Champion Pond water have not been assessed. Results of a sampling of the alternative water supply well and the Champion Pond water will be needed. Water quality analysis should include organic parameters in addition to dissolved and total metals. Current plans call for this sampling to be completed by CDM during late summer, 1988.

3.2.2 PLUME DELINEATION

The areal extent of the ground water contamination has been characterized to a certain degree during both the RI (Woessner, et al., 1984) and the draft FS (HLA, 1987). Sampling conducted during the FS was limited in spatial extent due to low reservoir stage. The result was that many wells in the plume vicinity were dry. The plume is not clearly defined along the interstate highway to the west of the Blackfoot River and north of the Clark Fork River. An additional round of sampling is recommended for approximately 15 more wells downgradient in the vicinity of the plume to confirm the extent of contamination. Figure 1 shows the proposed locations of domestic wells recommended for sampling. These domestic wells should be sampled during the Downstream Screening Study.

The vertical extent of the contaminant plume has not been defined downgradient of the reservoir. A set of multiple completion monitoring



LEGEND

⊕ PROPOSED STAFF GAGE LOCATION

△ PROPOSED PHASE II NESTED WELLS TO BE INSTALLED CONTINGENT UPON RESULTS FROM RESAMPLING OF DOMESTIC WELLS AND PHASE I WELLS

• WELLS SAMPLED BY HLA

+ DOMESTIC WELLS PROPOSED FOR SAMPLING

0 3000

SCALE: IN FEET

ORIGINAL SOURCE: HLA(1987)

PROPOSED GROUNDWATER MONITORING PROGRAM

CAMP DRESSER & McKEE
RIVERPOINT
2300 15th STREET, SUITE 400
DENVER, COLORADO 80202

CDM

FIGURE NO. 1

wells will be required which should be completed at approximately five locations. A transect normal to the furthest downgradient extent of the plume should be established (Figure 1) to provide information necessary to quantify the recharge/discharge relationships described in Section 3.2.4. These wells need to be completed at at least two depth intervals within the saturated zone of the alluvial aquifer. These wells should be sampled during the FS.

3.2.3 HYDROGEOLOGIC AND GEOCHEMICAL CHARACTERIZATION

Information necessary to characterize the Milltown site hydrogeology includes water levels, aquifer thickness and extent, hydraulic properties of the sediments and the aquifer. The extensive monitoring well network established during the RI (Woessner, et al., 1984) and the two additional monitoring wells installed by HLA (1987) provide sufficient spatial coverage upgradient of the Milltown Dam. However, water level data will be required further downgradient to map the major flow pathways originating from the reservoir. Existing domestic wells between the dam and Hellgate Canyon will be utilized to obtain water levels and map the aquifer thickness and extent. Information regarding depth to bedrock will also be required and can be compiled using existing data from well logs provided in the RI and draft FS reports and from domestic well drillers logs obtained during the Downstream Screening Study.

Aquifer tests conducted during the RI indicate a wide range in transmissivities measured (55,000 to 4,600,000 ft^2/day). A review of the data collected from these tests show that the aquifer is highly transmissive, therefore performance of reliable slug tests or aquifer pumping tests would be difficult. Since hydraulic conductivity measurements are a critical data need for computing total ground water fluxes moving through the system, a borehole dilution method should be used. Use of this method will require installation of a borehole to the top of the water table and a set of 3 observation piezometers to form a triangulation pattern around the borehole. Velocities computed from the

borehole can be used to back calculate a range of hydraulic conductivities using the hydraulic head differences observed in the observation wells.

Evaluation of the technical feasibility of the ground water containment alternative using infiltration trenches will require field-scale estimates of the infiltration capacity of the aquifer. Infiltration capacity is the limiting factor that may make this alternative infeasible. A pilot trench infiltration test will be required to measure the long-term infiltration rate of the actual system.

Geochemical characterization of the alluvial aquifer will be required to predict the rates of contaminant plume migration under the no action alternative. Sorption is one of the major processes controlling migration of arsenic and trace metals in the ground water. Quantification of the adsorption process will require measurement of partition coefficients (Kd) from batch and column tests in the laboratory. Samples will be required from uncontaminated portions of the alluvial aquifer to be used in these tests. Source water will be obtained from one of the wells in the most contaminated area below the reservoir sediments. The tests will provide representative values of Kd's for arsenic and other major contaminants of concern.

3.2.4 RECHARGE/DISCHARGE RELATIONSHIPS

There is no information available on the relationship between ground water and surface water downgradient of the dam. Upwelling of contaminated ground water into the surface flow of the lower Clark Fork River could be a significant migration pathway under the no action alternative. Flux estimates of ground water contribution to surface water contamination will require measurement of the vertical hydraulic head distribution in ground water across selected reaches of the river. A set of shallow and deep wells will be required along a transect on both sides of the river. This transect should be established at the downgradient extent of the arsenic

plume, to determine whether ground water is discharging to surface water in this area. Piezometric data from HLA (1987) indicate this may be occurring.

If it appears that the plume is migrating further downgradient in the alluvium, additional transects located between the dam and Hellgate Canyon may be required. Seasonal effects will be evaluated, if possible, by measuring water levels in these wells during a high flow period (May-June) and a low flow period (August-September). Water quality samples will be collected from these wells at the same time water levels are measured.

3.2.5 RECEPTORS

Residents of Milltown have been identified as receptors of ground water contamination. Other potential receptors are the residents of West Riverside, Pine Grove, and East Missoula. Additional receptors will need to be identified downstream along the Clark Fork River pending results from the Downstream Screening Study. The scope of the screening study includes a complete well inventory downgradient of the Milltown Dam to Hellgate Canyon. A door-to-door survey will also be conducted of residents in the vicinity of the contaminant plume identified during the Remedial Investigation (Woessner, et al., 1984) and supplemental investigations conducted by HLA (1987) for the draft FS.

3.2.6 BACKGROUND GROUND WATER QUALITY

The detailed analysis of ARARs may result in use of the Montana non-degradation standard. In this case, background levels of contaminants of concern will be required. Determination of background ground water quality will require sampling of approximately five domestic wells located upgradient of the Milltown site. These upgradient wells will need to be well away from the influence of the reservoir, as well as out of the potential alluvial water the Clark Fork River is contributing to valley

flow. If sufficient wells to establish background quality are not available, additional monitoring wells may be required.

3.3 SURFACE WATER

Various types of surface water data will be required to adequately evaluate each of the remedial action alternatives identified in Section 3.1. The CDM Interim Report (1986) identified surface water information as the primary data gap in the early draft FS (HLA, 1985). For the purpose of this report, required surface water data have been categorized into the following types of information needs:

- o Characterization of the existing surface water regime in terms of streamflow and water quality
- o Characterization of the physical and chemical processes controlling sediment deposition, scour, and transport through Milltown Reservoir
- o Characterization of recharge/discharge relationships of surface and ground waters downstream of Milltown Reservoir
- o Identification of potential receptors of contaminated surface waters
- o Characterization of background surface water quality

The adequacy of the existing surface water data, and consequently, the additional information required, in each of the above categories is discussed below.

3.3.1 CHARACTERIZATION OF THE SURFACE WATER REGIME

Baseline streamflow and water quality data are needed to define the range of conditions expected to occur under the no action alternative. This information then would provide a basis for comparison in evaluating each of the other alternatives in terms of expected effects to surface water. Historical data collected by the USGS, MDHES-WQB, and others should provide a sufficient record of streamflows on the Clark Fork and Blackfoot Rivers.

Frequency-duration analyses using these data could be performed to characterize the existing flow regimes.

A low-flow analysis of expected streamflows at the discharge point for treated water would be required for the treatment plant considered under Alternative No. 10 - Ground Water Extraction and Treatment. The analysis performed would depend on discharge permit requirements, although a common example would be the 7Q10, i.e., the minimum flow (averaged over a 7-day period) expected to occur, on average, once every 10 years. Data required for such an analysis are long-term continuous records of daily streamflows at the discharge location. Generally, a minimum of 10 years of continuous records are required to adequately define the 7Q10. The USGS generally performs these analyses on a periodic basis based on flow records at USGS gaging stations and reports the results in their "Streamflow Characteristics" publications. The applicability of these data to the FS would depend on the location of the treatment plant in relation to the gaging station.

The USGS database, containing surface water data collected under their normal water resources monitoring program and special studies conducted in the basin, represents a major source of long term surface water data. Although it is unlikely that these data can be validated to a Level B status, confirmation of their sampling and analytical procedures could be performed. USGS field data logs and streamflow rating curve development notes for the gaging stations of concern should be reviewed to check for proper sampling and calculation procedures. Splits of water quality samples collected by the USGS should be obtained and analyzed by a CLP lab; results could then be correlated to USGS analytical results to confirm and develop the relationships between USGS and CLP results. These relationships could then be used to evaluate previous USGS data collected for use in the FS evaluations. This process has been initiated under the current monitoring effort taking place during the MPC drawdown activities at the dam (see Section 2.2). Where long-term records are unavailable,

statistical multi-regression correlation techniques using available data should be employed to generate long-term historical records.

HLA (1987) performed a similar confirmation task by conducting concurrent sampling with that being conducted by the MDHES-WQB. Results indicated that HLA's TSS, calcium, and arsenic results compared closely with those of the MDHES-WQB. However, field temperature, magnesium, and nitrate results did not compare favorably between the two groups of data. It was suggested by HLA that the HLA results were not representative of actual conditions with respect to magnesium and nitrate.

The MDHES-WQB database represents a good source of relatively long-term (5 continuous years, 1984-1988) surface water data. QA/QC procedures (lab and field) are routinely employed and are well-documented. WQB has periodically split samples with the USGS at several stations above Milltown Reservoir with good comparability. Comprehensive data are available, including nutrients, metals, TSS, VSS, pH, temperature, and biological parameters. Currently, there are more than 70 data sets available for stations upstream and downstream of Milltown Reservoir which were collected under a variety of streamflows and conditions. The WQB and USGS split sample results should be reviewed to verify comparability. Based on the USGS data confirmation effort discussed previously and this review, an assessment of USGS and/or WQB data usability may then be made.

In evaluating any alternative under the contingency of partial and significant failure of upstream sediment control measures, it will be necessary to have information regarding expected levels of contaminated sediment inflow to the Milltown site. Previous investigations conducted along the Upper Clark Fork River (Ingman, 1985; Rice and Ray, 1985; Moore, 1985b; and USGS, 1987) present data concerning bed, bank, and floodplain sediments which can be used to generate order-of-magnitude estimates of expected sediment loads under catastrophic flood conditions.

Consideration of a 100-year flood event occurrence at the Milltown site in evaluating alternatives will require additional information on the predicted magnitude (flood hydrograph and peak flow) of the event and the corresponding 100-year floodplain to predict the location of sediments likely to become inundated. Data collected by MPC (Curtis, 1985) in support of its FERC application will provide much of the needed information that should be obtained for the FS. No evidence of previous floodplain studies in the Milltown area has been found, thus a backwater stream profile analysis using an appropriate model (e.g., the U.S. Army Corps of Engineers HEC-2 model) will be needed to locate the 100-year floodplain.

3.3.2 SEDIMENT TRANSPORT CHARACTERIZATION

To predict downstream effects on surface water quality from reservoir releases under the no action or other alternatives, it is necessary to characterize the physical processes by which sediment transport occurs within and downstream of the reservoir. A reservoir budget analysis is necessary to define the processes of deposition and scour. A preliminary evaluation of models available to assess sediment transport processes is included in Section 5.0 of the FS Work Plan. Whether this analysis is performed on a conceptual or numerical (modeling) level, specific information is needed:

- streamflows and velocity profiles (vertical and lateral) under a range of flow conditions on the Clark Fork upstream and downstream of the reservoir, the Blackfoot upstream, and within the reservoir (at a minimum of three cross-sections)

- water chemistry under the same range of flows and at the same locations specified above; parameters to include, at a minimum, are total and dissolved metals (contaminants of concern), major ions, temperature, pH, conductivity, and D.O.

- suspended sediment concentrations under the same range of flows and at the same locations specified above

- contaminant concentrations and grain-size distributions of the suspended sediment sampled under the same range of flows and at the same locations specified above; due to the generally low concentrations of suspended sediment under all but extremely high

flow conditions, it is probably necessary to approximate the chemistry and suspended sediment grain-sizes using bed load samples (see next item)

- o contaminant concentrations (total metals) and grain-size distributions of stream and reservoir bed, bank, and floodplain sediments

- o channel and reservoir geometry (including bank areas which would be inundated under high flow conditions), channel slopes, and stream bed and bank materials/vegetation documentation (to estimate roughness coefficients)

Sampling activities will be required to acquire the above information. It is important that these data (with the exception of geometry) be sampled over a range of flow conditions. If the ARARs analysis resulted in a criterion whereby the selected alternative must meet the specified ARARs under a defined flow condition (such as at any flow less than or equal to the 100-year flood), it would be inappropriate to extrapolate data from low flow samples to predict high flow consequences. If sampling is at high flows as well as low flows, impacts could be predicted with a greater degree of confidence. However, extrapolation beyond the largest flow condition monitored is not recommended to predict quantifiable impacts; such predictions are recommended to be in a qualitative form. Results of previous investigations indicate that acute impacts of sediment discharges in the Clark Fork River may be related to the onset of runoff events (Phillips, 1985; HLA, 1987); high flow sampling should thus be performed at the onset of the event being monitored during the rising limb of the streamflow hydrograph.

Similar information would also be useful to characterize the effects of MPC drawdown events. Drawdown conditions could be considered as a simulation of a naturally occurring extreme flow event. Data collected under various MPC drawdown events would provide a basis for evaluating the no action alternative and for determining allowable operating conditions for the reservoir under the institutional controls alternative. Discharge, water quality, reservoir water surface elevation, and drawdown rates, collected on a daily (at a minimum) basis are needed. This process has been

initiated under the current monitoring effort taking place during the MPC drawdown activities at the dam (see Section 2.2). Historic streamflow records, the Milltown Reservoir area-capacity curve, and dam outlet and spillway rating curves will be needed to model routing of flows through the reservoir under various operating rules to be considered; the reservoir data should be obtained from MPC.

Under the source control alternative, sediment loading and grain-size distribution data under various flow conditions will be needed for by-pass design to ensure that significant deposition within the channels does not occur. Data compiled and collected for the reservoir budget will provide the needed information. Part of the evaluation of the bypass channels would involve determining sediment releases without the influence of the reservoir. With the information obtained to perform a reservoir sediment budget analysis, a similar analysis with the reservoir replaced by the bypass channels should be conducted.

Sediment loading to the reservoir must also be known for the evaluation of the dam engineering alternative, to estimate how much time it would take before the modified reservoir's sediment storage capacity would be exhausted (i.e., return to present conditions).

Extensive use of historical data, collected primarily by the USGS and MDHES-WQB, is anticipated to be used in conjunction with the data collected above. It is assumed that historical data would be representative of future conditions in terms of source materials (a scenario in which input water quality is improved would also be considered in the FS). As discussed in Section 3.3.2, confirmation of USGS data is currently underway. It is suggested that concurrent monitoring also be performed in conjunction with MDHES-WQB to confirm sampling and analytical procedures. One concurrent round of sampling at the two upstream, one downstream, and one reservoir monitoring stations with CLP analyses for comparison are needed.

The remedial investigation study by Woessner, et al. (1984) provides valuable information on reservoir sediments, particularly as these data have been validated. Reservoir sediment data collected by HLA (1987) for the draft FS should also be used; based on the preliminary results of a Level A/B review, most of these data will meet EPA's Level A/B quality assurance criteria.

MPC studies discussed in Section 2.1 provide useful surface water and sediment data. The sedimentation study (Curtis, 1985) may provide a sound basis to develop the reservoir budget model; confirmation of the study may be possible if the data used in the model are made available by MPC. Confirmation of MPC data collected during drawdown events is currently taking place in conjunction with the USGS data confirmation effort.

The other sources of information discussed in Section 2.0 should be used to provide a more complete picture of the sediment transport processes present at Milltown. However, validation and confirmation of data are unlikely and may not be necessary providing that the final selection of an alternative is not based on such data.

3.3.3 RECHARGE/DISCHARGE RELATIONSHIPS

As discussed in Section 3.2, there is no information available on the relationship between ground and surface water downgradient of the dam. Upwelling of contaminated ground water into the surface flow of the lower Clark Fork becomes a surface water impact under the No Action alternative at the point (reach) of upwelling. Similarly, defining the contribution of surface waters from the Clark Fork to the Missoula sole source aquifer is a key issue in assessing the impact of contaminated sediment releases for Milltown Reservoir.

In defining the ground water plume from Milltown Reservoir recharging to the Clark Fork downstream of the dam, streamflow and water quality sampling below the dam at various locations would help define areal extent and

quantity of the recharge reach in the river. Selection of locations would be based on the findings of the ground water monitoring performed for plume definition.

Consideration of effects on the Missoula Sole Source Aquifer may be included in the FS. The recently completed application for the Sole Source Aquifer and other applicable data is being reviewed as part of the Downstream Screening Study being conducted by MDHES.

3.3.4 SURFACE WATER RECEPTORS

Identification of all potential receptors of contaminated surface waters stored within or released from Milltown Reservoir is needed. Potential receptors include any communities or individuals downstream of the dam who divert waters from the Clark Fork for drinking water. Other receptors could include downstream agricultural users diverting from the Clark Fork for stock watering or irrigation (lands under irrigation would need to be identified). Recreational users on and downstream of the reservoir are also potential receptors. Finally, aquatic biota within and downstream of the reservoir are receptors. Receptor information is needed for the Endangerment Assessment. Major risks are expected to be directly below the dam, with level of endangerment decreasing downstream due to the effects of dispersion and dilution.

The Downstream Screening Study will provide an initial screening of potential surface water receptors.

3.3.5 BACKGROUND SURFACE WATER QUALITY

Background levels of contaminants will be needed should the ARARs analysis result in application of the Montana non-degradation standard. For surface waters, characterization of water quality contaminant levels directly upstream of the Milltown site on the Clark Fork and Blackfoot Rivers will provide the background levels necessary (upstream Clark Fork contaminant

levels may not represent "true" background due to upstream contamination). The sampling required under the characterization of sediment transport processes, along with confirmed data previously collected at these sites by the USGS and others will provide sufficient information to determine background contaminant levels.

3.4 SEDIMENT

Reservoir sediment characterization is critical to the evaluation of remedial alternatives that involve physical removal, chemical treatment or stabilization of sediments. Information required to evaluate these alternatives include:

- Extent of contaminated sediments within the reservoir
- Geochemical characterization of the sediments
- Total volume of contaminated sediments
- Availability of suitable on-site or off-site disposal sites.

Specific data on the reservoir sediments are available primarily from three sources: the RI study conducted by Woessner et al. (1984); Montana Power Company's FERC permit application (MPC, 1985); and the supplement field investigations conducted by HLA (1987). Woessner et al. (1984) had collected grab samples at 34 locations and depth samples from 6 boreholes which extended to depths of 5 feet. Ten borings were installed by MPC (1985) and sediment samples collected to depths of up to 20 feet. HLA (1987) had installed 24 boreholes along six transects across the reservoir extending to the full depth of the fine-grained reservoir sediments ranging from less than 5 to 25 feet. Data and analytical results are provided in the individual reports from these studies.

The adequacy of these sediment data to address information needs in the various categories is described below.

3.4.1 EXTENT OF CONTAMINATION

The areal and vertical extent of contaminated sediments has been adequately characterized during the supplemental investigations conducted during the draft FS (HLA, 1987). The spatial distribution of the 24 borings completed and the regular depth sampling conducted by HLA (1987) is adequate for a technical evaluation of alternatives related to the physical removal of the reservoir sediments.

3.4.2 GEOCHEMICAL CHARACTERIZATION

Although an extensive data base exists on the geochemical characteristics of the sediments, there is still a lack of complete understanding of the interaction of sediments and processes controlling contribution to surface water and ground water contamination. Ongoing research studies at the University of Montana described in Section 2.2 are expected to provide information necessary to characterize the sediment geochemistry. Further data collection during the FS is not recommended prior to a detailed evaluation of existing data.

3.4.3 VOLUME OF SEDIMENTS

Total volume of contaminated sediments were calculated by HLA (1987) using 24 boreholes along 6 transects completed across the full depth of the sediments. This volume estimate of 6.6 million cubic yards is reasonable for a technical evaluation of alternatives involving sediment removal.

3.4.4 AVAILABILITY OF DISPOSAL SITES

Evaluation of remedial alternatives which involve disposal of sediments will require identification through initial screening of potential on-site and off-site disposal sites. Initial screening of potential sites will require an air photo reconnaissance survey, site visits, and review of existing geologic maps. Several potential disposal sites were identified

in the draft FS by HLA (1987). These sites included four on-site areas and two off-site areas. However, there was a lack of discussion on the basis for selecting these particular sites. Therefore, the adequacy of information related to disposal sites was not evaluated. Further definition of suitable sites will require detailed hydrogeologic information such as depth to the water table, aquifer hydraulic characteristics, and geotechnical properties of the subsurface soils.

3.5 PUBLIC HEALTH EVALUATION

The Endangerment Assessment (EA) included in the Milltown Site Final Interim Report (CDM, 1986) provides a preliminary basis for the public health evaluation. The EA addresses the ground water ingestion pathway regarding receptors in Milltown. There are several information needs however, which should be addressed in order to support preparation of a baseline public health evaluation. The additional data requirements include the following:

- Background concentrations of site contaminants in the relevant media should be determined in order to estimate the incremental risks associated specifically with the Milltown Reservoir site. Background concentrations may also provide a lower limit for action levels. Discussions of contaminant levels and data needs for ground water, surface water, soils, and sediments are found in previous sections of this report. Discussion of biota is found in Section 3.6.

- Further discussion and/or investigation of the hydrogeologic conditions is needed to adequately characterize the contaminated aquifer. Plume migration and hydrogeologic characterization are addressed in Sections 3.2.2 through 3.2.4 of this report.

- The Exposure Assessment should be expanded to include or at least address all potential exposure pathways and all potential receptors. For example, the EA does not consider incidental ingestion of sediments by children playing along the shoreline of the reservoir or incidental ingestion of surface water due to recreational use of the river or reservoir. When the current or potential extent of ground water contamination is clarified, additional ground water receptors may be identified. Potential receptors of ground water and surface water are also discussed in Sections 3.2.5 and 3.3.4 of this report, respectively.

3.6 ENVIRONMENTAL ASSESSMENT

Specific environmental resources that will be assessed at the Milltown Reservoir site are discussed in this section. Data needs for the environmental assessment will be further refined through coordination and consultation with MDHES and MDFWP. through this coordination a list of "species of concern" will be agreed upon. These species will be the focus of the environmental assessment. Data needs relative to the status of these indicator organisms will then be defined. In general, data collected as part of previous studies will be used to evaluate FS Alternatives.

3.6.1 AQUATIC LIFE

The assessment of aquatic resources will require coordination with the Montana Department of Fish, Wildlife, and Parks (MDFWP) to identify species of concern, characterize the aquatic environment, and to evaluate the potential effects of remedial alternatives on species of concern and their habitats.

The environmental assessment should address the following informational needs:

- o Species of Concern. Species may be abundant and economically important, threatened or endangered, or ecologically important for the food chain. At a minimum, the following species may occur at the Milltown site and should be considered:

Species	Reason
Rainbow Trout	Abundant, economically important
Brown Trout	Abundant, economically important
Westslope Cutthroat Trout	Threatened species (MDFWP, 1986)
Shorthead Sculpin	Threatened species (MDFWP, 1986)
Tailed Frog	Threatened species (MDFWP, 1986)
Daphnia sp.	Representative of ecologically important species, abundant toxicological data

This list is presented for consideration by MDHES and MDFWP. The final list of species of concern will be determined in consultation

with MDFWP. Consultation will include identification of the life stages of importance. For instance, to protect the stream for spawning as compared to adult trout habitat will require emphasis on different environmental features.

- o Aquatic Life Toxicological Information. Conduct a literature search of existing toxicological data to determine if existing ARARs are protective of species of concern. The federal AWQC for aquatic wildlife are based on nationwide surveys of the toxicological literature. Reviews of that literature occasionally indicate that the AWQC for a particular contaminant and species is over or under protective.

- o Action Levels. If existing ARARs are not protective, it will be necessary to select potential action levels that are protective of the species of concern.

- o Water Quality. Collect water quality data upstream, downstream, and within the reservoir under various flow conditions and during drawdown conditions of the dam. Data sources and deficiencies of surface water quantity and quality are addressed in Section 3.3. For aquatic wildlife, water quality parameters should include at least TSS, dissolved oxygen, and dissolved/total metal concentrations. Historical surface water data has been taken at USGS stations up and downstream of the Milltown Dam. Further water quality sampling is needed within 300 feet downstream of the dam within the reservoir (Section 3.3), and at other potential points of contaminated ground water discharge to surface water (Section 3.3). As in Section 3.3, flow and water quality should be collected during spring runoff, a low flow period, and on the rising limb of a flood hydrograph.

- o Evaluation of Biomonitoring Results. To substantiate ARAR levels, biomonitoring should be conducted in conjunction with water quality sampling. Suggested biomonitoring species include Ceriodaphnia, minnows, fingerling trout, and adult trout. Biomonitoring should be coordinated with MDFWP and the EPA as several future studies are planned in the Milltown area, as listed in Section 2.2. Biomonitoring of a Milltown Reservoir drawdown would be useful to evalute the protectiveness of water quality ARARs.

- o Evaluation of Habitat Issues. According to Dennis Workman (personal communication, June 20, 1988), trout numbers and diversity are thought to be less than optimal for the given habitat downstream of the dam because of the physical interference of the dam and/or water quality problems. Optimum instream flow determination, based on wetted perimeter techniques (MDFWP), is proposed by MDFWP (Section 2.2) downstream of the Milltown Dam. These instream flows can be compared to those suggested in Section 3.3 for discharge permitting under Feasibility Study Alternative No. 10.

3.6.2 VEGETATION

Vegetation assessments typically include vegetation mapping and identification of important habitats for threatened or endangered wildlife or plant species. In arid or semi-arid regions such as Montana, aquatic and riparian habitats may be deemed important simply because these habitats are relatively scarce. The phytotoxicity and bioaccumulation potential of site contaminants should be addressed in this section.

- Vegetation at the Milltown site was characterized in MPC's FERC application (1985) for the Milltown Reservoir area. Plant communities were identified according to soil characteristics and species composition and mapped along both the Blackfoot and Clark Fork arms of the reservoir. According to MPC (1985), no threatened or endangered plant species grow in the Milltown site. Wetland mapping still needs to be conducted upstream and downstream of the dam (Section 3.6.4) for habitat evaluation.

- Important habitats for locally important wildlife or plant species and for threatened or endangered species need to be identified.

- Phytotoxicity and bioaccumulation of site contaminants in plants have been addressed in the FERC application (MPC, 1985) as part of a sampling program that characterized metals contamination in leaves of several common plant species at Milltown Reservoir. Most metal levels fell below critical plant levels in the leaves, the point at which adverse affects to growth and development occur, and below the Maximum Tolerable Dietary Level for animals.

- Extent of contamination of vegetation on lands irrigated by contaminated surface waters is unknown at this time and should be addressed if such lands are identified in the downstream screening study.

3.6.3 WILDLIFE

If species of concern are determined to be potential contaminant receptors, the toxicity of site contaminants to wildlife and the potential for bioaccumulation will be investigated. The following information needs should be addressed:

- o Wildlife species of concern. At a minimum, the following species should be considered:

Species	Rationale
Peregrine Falcon	Endangered species
Bald Eagle	Endangered species
Common Loon	Threatened species (MDFWP, 1986)
Great Blue Heron	Common
Canada Goose	Introduced
Other nesting water birds	To be selected through coordination with MDFWP

This preliminary list will be a basis for consultation with the MDFWP.

- o Toxicological data. Literature survey of existing toxicological data is needed to determine potential risks to and bioaccumulation potential of the wildlife species of concern for site contaminants.

- o Risk of Bioaccumulation. MPC (1985) reported heavy metal concentrations in plants at Milltown Reservoir generally below Maximum Tolerable Dietary levels for animals (Section 3.6.2). Those plants exceeding these standards were non-forage species such as cattail. Risk of bioaccumulation in grazing animals appears to be small at Milltown Reservoir. The U.S. Fish and Wildlife Service (USFWS) (1986) completed chemical analyses on 35 biological samples from birds, fish, and aquatic insects finding high levels in two individuals only; a Canada goose and common merganser. Additional testing in fish populations and other food sources of species of concern is suggested.

- o Identify important habitats for locally important or threatened or endangered wildlife species and determine whether or not these habitats will be adversely affected by FS Alternatives. For instance, Alternative 2 may provide for institutional control of dam operations as related to habitat protection.

3.6.4 WETLAND AND FLOODPLAIN ASSESSMENT

Wetland and floodplain information is needed that would be responsive to CERCLA guidance (Policy on Floodplain and Wetland Assessments for CERCLA Action, W.N. Hedeman & D. Lucero, August 1985) that suggests compliance with Executive Orders 11988 and 11990 and Appendix A of 40 CFR Part 6. To perform the assessment as part of the FS, a 100 year floodplain determination (See Section 3.3, Surface Water) and wetland mapping are

needed. Since Section 404 of the Clean Water Act is a potential ARAR for the site, wetland delineation should employ U.S. Army Corps of Engineers criteria. Classification of wetlands should employ the USFWS classification of wetlands (Cowardin et al., 1979). No wetland mapping is currently available for the site.

3.7 ALTERNATIVE DEVELOPMENT INFORMATION NEEDS

Additional information is also needed to evaluate the alternatives and address the concerns discussed in Section 3.1. For performing a reservoir sediment budget analysis, MPC operational plans for Milltown Reservoir must be known to properly evaluate the No Action and Institutional Controls alternatives. Significant changes in operations (such as scheduling, frequency, and magnitude of future drawdowns) could result in very different impacts in the future than those that have occurred historically.

For Alternative Nos. 3 and 4, information on potential disposal sites for the Milltown sediments will be required. A survey of available RCRA and non-RCRA sites is needed. Information required will include locations of disposal sites, transportation options from Milltown to the sites, and capacities of the sites for receiving and storing the volume of sediments removed from Milltown.

Under Alternative No. 8 - Source Control, a channel by-pass would be constructed to reroute Clark Fork River flows, possibly along the south side of the reservoir. In addition, it would be necessary to construct a by-pass for the Blackfoot River in order to totally isolate the reservoir sediments from natural flows. This alternative would effectively eliminate the use of Milltown Dam as a hydroelectric or storage facility. Detailed topographic mapping of the reservoir and surrounding area will be required in order to identify potential routes for the by-pass channels. Geotechnical information to evaluate stability and depth to bedrock is needed (would prefer to avoid blasting rock for channel construction). Design flows would be required for proper sizing of the channels. This

information would also be needed, though to a lesser degree of detail, in order to determine the proper location and capacity for a temporary diversion for Alternative No. 3 - Removal and Disposal of Sediments (Without Treatment), Alternative No. 4 - Removal, Treatment, and Disposal of Sediments, and Alternative No. 7 - Reservoir Sediment and Channel Stabilization.

For Alternative No. 11 - Dam Engineering, evaluating raising the dam would require detailed topographic, geologic, and geotechnical information along the valley at and below the existing dam to determine a suitable site for the enlarged dam and to calculate the increased storage capacity provided. There is little potential for raising the dam at its present location due to the widening of the valley at elevations greater than the existing dam height.

To evaluate the efficacy of MPC sediment disposal ponds utilized during the dam and powerhouse rehabilitations, data from MPC must be obtained regarding locations of the ponds, methods of removal and disposal, volume and chemical characterization of the removed sediments, and protective measures taken to prevent resuspension of disposed sediments.

4.0 REFERENCES

Aamodt, P.L. 1978. Uranium Hydrogeochemical and Stream Sediment Pilot Study of the Boulder Batholith, Montana. Los Alamos Scientific Laboratory Informal Report LA-7176-MS.

Andrews, E.D. 1986. Longitudinal Dispersion of Trace Metals in the Clark Fork River, Montana. Chapter 11 in Chemical Quality of Water and the Hydrologic Cycle, by Averett, Robert C. and McKnight, Diane M. Lewis Publishers, Inc. 1987.

Braxton, David E. 1980. Uranium Hydrogeochemical and Stream Sediment Reconnaissance Data Release for the Butte NTMS Quadrangle, Montana, Including Concentrations of Forty-two Additional Elements. U.S. Department of Energy. Informal Report LA-7668-MS. May.

Brook, E. and J. Moore. Undated. Distribution and Particle Size Control of Metals in Bed Sediment from the Clark Fork River, Montana, USA. Submitted to Water Research.

Burton, G., A. Drotar, J. Lazorchak, and L. Bahls. 1987. Relationship of Microbial Activity and Ceriodaphnia Responses to Mining Impacts on the Clark Fork River, Montana. Archives of Environmental Contamination and Toxicology 16, 523-530.

Camp Dresser & McKee Inc. (CDM). 1986. Final Interim Report, Milltown Site, Milltown, Montana. October 30.

CH2M Hill. 1983. Draft Remedial Action Master Plan, Milltown, Montana. EPA document number 01.8V23.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Dept. Interior, Fish and Wildlife Service, FWS/OBS 79/31. 103 pp.

Curtis, W.L., 1984. Milltown Hydroelectric Project Engineering Evaluation. Montana Power Company, Butte, Montana, FERC Project No. 2543.

_____. 1985. Milltown Reservoir and Clark Fork River Sedimentation Study. FERC Project No. 2543. Montana Power Company, Butte, Montana. August. 22 pp.

Dodson, M., D. Minno, P. Davis, J. Greene, G. Phillips, and M. Kerr. Undated. Three Case Studies on the Use of Ceriodaphnia as Indicators of Water Quality in Western Trout Streams. 19 pp.

Duffield, J. 1984. Refinement of Recreational Value Estimates on the Upper Clark Fork River.

Engineering Management Inc. 1982. Dam Safety Invetigations, Milltown Dam. San Francisco, California. March.

Harding Lawson Associates (HLA). 1986. Draft Milltown Reservoir Feasibility Study, November 12.

_____. 1987. Volume I - Draft Milltown Reservoir Data Report, Supplemental Investigations Conducted Under the Feasibility Study. Denver, Colorado. March 16.

_____. 1987a. Draft Report. Supplemental Ground Water Investigation - Arsenic Speciation - Milltown Reservoir CERCLA Site. HLA Job No. 17461.002.1.

Hydrometrics. 1985. Water Resources Impacts Resulting from Proposed Rehabilitation of the Milltown Hydroelectric Project. Prepared for the Montana Power Company. May 3.

Ingman, G.L. 1985. Champion International Frenchtown Mill Discharge Permit MT-0000035, Data Report - Volumes I and II. Montana Department of Health and Environmental Sciences (MDHES). December. 589 pp. (Vol. I), 380 pp. (Vol. II).

Johns, C. and J. Moore. 1985. Metals in Bottom Sediments of Lower Clark Fork Reservoirs. Final Report submitted to Montana Water Resources Research Center, Montana State University. Bozeman, Montana.

Johnson, H. 1987. Interagency Coordination Meeting Minutes, Clark Fork River Basin Project. Missoula, Montana. February 26.

Lambing, John H. 1987. Water Quality Data for the Clark Fork and Selected Tributaries from Deer Lodge to Milltown, Montana, March 1985 through June 1986. USGS Open File Report 87-110. Helena, Montana. March. 47 pp.

Marcoux, R. 1970. Western Montana Fishery Study - Inventory of Waters of the Project Area. Montana Fish and Game Deparment. Fisheries Division. Job Progress Report. Project No. F-12-R-17. Job No. I-a. 8 pp.

Mehring, S. 1985. The Impact of a Drawdown on the Movement of Heavy Metals Through a Small Impoundment on a Mine Contaminated River. University of Montana. May 17. 38 pp.

Montana Department of Fish, Wildlife, and Parks (MDFWP). 1985. Middle Clark Fork River Fishery Monitoring Study: Evaluation of the Effects of Pulp and Paper Mill Effluents on the Fish Population, Status Report. Missoula, Montana. October 15.

_____. 1986. Application for Reservations of Water in the Upper Clark Fork River Basin. Helena, Montana. November.

Montana Department of Health and Environmental Sciences - Water Quality Bureau (MDHES-WQB). 1988. Draft Study Plan: Blackfoot River Water Quality Study, 1988-1989.

Montana Power Company (MPC). 1985. Application for Amendment of License - Milltown Project No. 2543. Butte, Montana. July.

_____. Letter Reports from F. Pickett (Senior Biologist, MPC) to J. Knoy (RPM-EPA, Helena) of results of Milltown Dam Rehabilitation Project Water Quality Monitoring Program from September 21, 1986 through April 4, 1987.

MontPIRG. 1983. Health Study of Milltown, Montana.

Moore, J. W., Ficklin, and C. Johns. Undated. Partitioning of Arsenic and Metals in Reducing Sulfidic Sediments. Environmental Science and Technology (in press).

Moore, J., E. Brook, and C. Johns. Undated. Grain Size Partitioning of Metals in Contaminated, Coarse-Grained River Floodplain Sediment: Clark Fork River, Montana. Environmental Geology and Water Science (in press).

_____, 1985b. Source of Metal Contamination in Milltown Reservoir, Montana: An Interpretation Based on Clark Fork River Bank Sediment. Report to the USEPA. Septemer 1985.

Nelson, W.H. and J.P. Dobell. 1961. Geology of the Bonner Quadrangle, Montana. U.S. Geological Survey Bulletin. 1111-F.

Peters, Donald J. 1981. Inventory and Survey of the Lower Clark Fork, Blackfoot, and Bitterroot Rivers. 1980-1981. Montana Department of Fish, Wildlife, and Parks Job Progress Report. Project No. F-12-R-27, Job I.b.

_____. 1985. Western Montana Fishery Investigation, Inventory and Survey of the Lower Clark Fork, Blackfoot, and Bitterroot Rivers. Montana Dept. of Fish, Wildlife, and Parks, Fisheries Division. Job Progress Report. Project No. F-12-R-31. Job No. I-b.

_____. 1988. Personal communication, June 20 to L. Buchanan, CDM.

Phillips, G.R. 1982. Letter to Ken Alkema, re: Montana Department of Fish, Wildlife, and Parks, Job Progress Report by Donald J. Peters, February 1981.

_____. 1985. Relationships Between Metals, Flows and Fish Populations in The Upper Clark Fork River. Presented at Clark Fork River Symposium, Montana Academy of Sciences 45th Annual Meeting, Montana College of Mineral Science and Technology, Butte, Montana, April 19, 1985.

Rennick, R.B., R.C. Postle, and F.F. Munshower. 1984. Floral survey of Clark Fork River sediment upstream from the Milltown Dam. Montana Agric. Exp. Sta. Reclam. Res. Unit. Montana State University, Bozeman, Montana. 24 pp.

Rice, P.M. and G.J. Ray. 1984. Floral and Faunal Survey and Toxic Metal Contamination Study of the Grant-Kohrs Ranch National Historic Site. 92 pp.

_____. 1985. Heavy metals in Floodplain Deposits Along the Upper Clark Fork River. Proceedings - Clark Fork River Symposium. Montana Academy of Sciences. April 19. pp. 26-45.

Udaloy, Anne G. 1988. Arsenic Mobilization in Response to the Drawing and Filling of the Reservoir at Milltown, Montana. University of Montana. 140 pp.

U.S. Environmental Protection Agency (USEPA). 1985. Evaluation Criteria for Existing Data from CERCLA Study Areas.

_____. 1985b. STORET System Retrieval for CDM, Upper Clark Fork River Drainage, Retrieved by Richard Satirous, EPA Region VIII.

U.S. Geological Survey (USGS). 1987. Water Resources Data for Montana (published annually).

_____. 1988. Personal communication, September 29, from Mel White (USGS, Helena) to D. Smith, CDM.

Woessner, W.W. and M.A. Popoff. 1982. Hydrogeologic Survey of Milltown, Montana and vicinity. Department of Geology, University of Montana, Missoula.

Woessner, W.W., J.M. Moore, C. Johns, M. Popoff, L. Sartor, M. Sullivan. 1984. Arsenic Source and Water Supply Remedial Action Study, Milltown, Montana. Department of Geology, University of Montana, Missoula, Montana, 448 pages.

Woessner, W.W., and J.M. Moore. 1988. Personal communication, June 14, to J. Stibrich, CDM.

Wood, J. 1986. Preliminary Analyses of Milltown Biological Samples - Interim Report. Letter Report from J. Wood (U.S. Dept. of the Interior, Fish and Wildlife Service, Billings, Montana) to J. Wardell (USEPA, Helena, Montana) dated September 8, 1986.

Workman, D. 1988. Personal communication, June 20 to L. Buchanan, CDM.

APPENDIX C

CHEMICAL DATA FOR SEDIMENT AND CORE SAMPLES TAKEN FROM WOESSNER, ET. AL., 1984

LOCATION MAPS FROM WOESSNER, ET. AL., 1984 AND HLA, 1986

CHEMICAL DATA FOR SEDIMENT AND CORE SAMPLES HLA, 1986

Table C.1

TOTAL METAL CONCENTRATIONS (ug/g)
GRAB SAMPLES

Element	Group[1]	Mean	Std. Dev.	Range
Arsenic	BF	7.73	2.078	55 - 13
(As)	CF	57.56	23.177	12.5 - 126
Manganese	BF	281.36	57.2456	202 - 361
(Mn)	CF	1290.0	1160.57	455 - 6110
Iron	BF	21163.63	1396.6193	18500 - 23400
(Fe)	CF	22855.76	5270.9833	15500 - 33200
Copper	BF	40.18	31.266	16.5 - 131
(Cu)	CF	22855.76	177.0202	192 - 939
Zinc	BF	127.91	84.2324	60 - 373
(Zn)	CF	1766.96	1426.8995	623 - 5320
Lead	BF	18.11	5.0735	12 - 26
(Pb)	CF	67.9615	19.5397	37 - 125
Cadmium	BF	0.6818	0.4423	0.2 - 1.5
(Cd)	CF	6.2692	3.7481	2.6 - 16.0

(1) BF = Blackfoot arm of reservoir
CF = Clark Fork arm of reservoir

Table C.2

ACETIC ACID EXTRACTABLE METALS (ug/g)
GRAB SAMPLES

Element	Group[1]	Mean	Std. Dev.	Range
Arsenic (As)	BF	1.47	1.5043	0.5- 5.8
	CF	15.10	4.4108	4.7- 24.5
Manganese (Mn)	BF	152.7	39.5755	95.0- 230.0
	CF	747.2	435.4544	284.0- 1,730.0
Iron (Fe)	BF	902.7	164.0320	620.0- 1,200.0
	CF	1,242.	488.5646	580.0- 2,500.0
Copper (Cu)	BF	9.4	11.9385	4.0- 41.0
	CF	236.5	108.0956	108.0- 555.0
Zinc (Zn)	BF	30.3	59.9074	2.0- 200.0
	CF	1,310	1,074.8809	470.0- 3,560.0
Lead (Pb)	BF	13.6	4.4578	7.8- 21.0
	CF	24.9	10.6298	10.0- 54.0
Cadmium (Cd)	BF	1.2	0.4622	0.5- 2.0
	CF	5.6	3.2254	1.5- 12.5
Ni(ppb)	BF	2,053	1,400.4024	388.0- 5,520.0
	CF	4,794	2,881.7418	1,400.0-10,850.0

(1) BF = Blackfoot arm of reservoir.
CF = Clark Fork arm of reservoir.

Table C.3

PORE WATER CONCENTRATIONS (mg/l)
GRAB SAMPLES

Element	Group[1]	Mean	Std. Dev.	Range
Arsenic	BF	0.0058	0.0027	0.0024 - 0.011
(As)	CF	0.0507	0.0983	0.0019 - 0.451
Manganese	BF	1.7893	1.4793	0.1240 - 4.5
(Mn)	CF	6.8873	7.1706	0.0000 -29.0
Iron	BF	0.3891	0.8530	0.0610 - 2.5
(Fe)	CF	1.9478	3.4980	0.0280 -15.0
Copper	BF	0.0092	0.0122	0.0000 - 0.032
(Cu)	CF	0.0087	0.0153	0.0000 - 0.064
Zinc	BF	0.0465	0.0653	0.0000 - 0.177
(Zn)	CF	0.1916	0.4930	0.0000 - 2.7
Lead	BF	0.0058	0.0064	0.0000 - 0.015
(Pb)	CF	0.0019	0.0041	0.0000 - 0.017
Cadmium	BF	0.0013	0.0013	0.0000 - 0.0035
(Cd)	CF	0.0020	0.0035	0.0000 - 0.016
Nickel	BF	0.0649	0.0354	0.0000 - 0.282
(Ni)	CF	0.0222	0.0050	0.0000 - 0.098

(1) BF = Blackfoot arm of reservoir.
CF = Clark Fork arm of reservoir.

Table C.4

Arsenic in total extractions from cores (all values expressed as ug As/g dry wt. sediment).

Core #	Mean	Std. Dev.	Minimum	Maximum	n
1	6.42	1.02	5.00	8.00	6
2	112.78	107.19	35.00	350.00	9
3	660.00	498.12	84.00	1590.00	16
4	181.92	164.03	21.00	469.00	13
5	180.40	101.29	60.00	387.00	15
6	466.00	356.64	101.00	1420.00	11

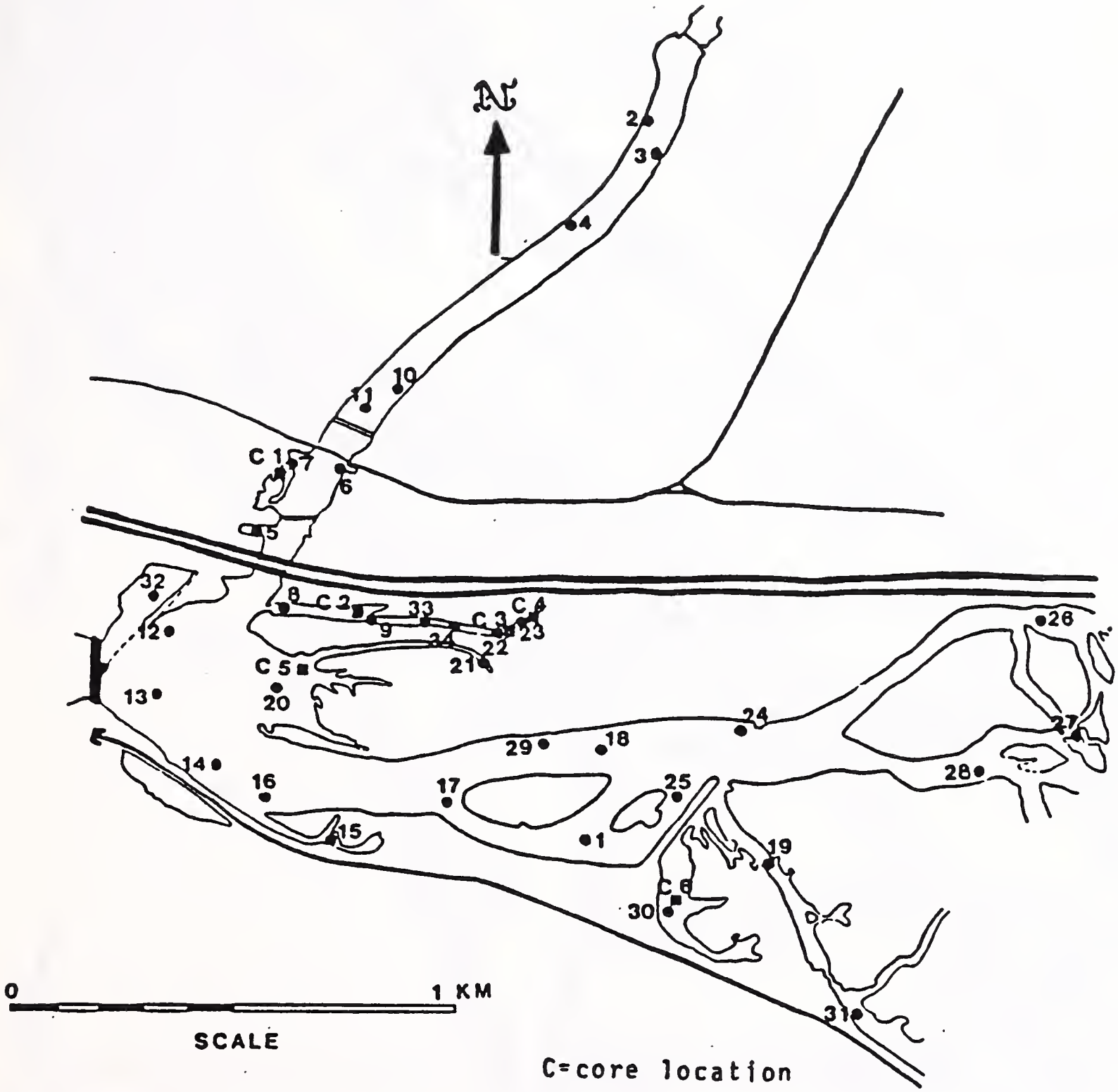


Figure C-1: Location of Sediment Grab Sampling Sites and Sediment Core Sites. Milltown Reservoir. (From: Woessner et al, 1984).

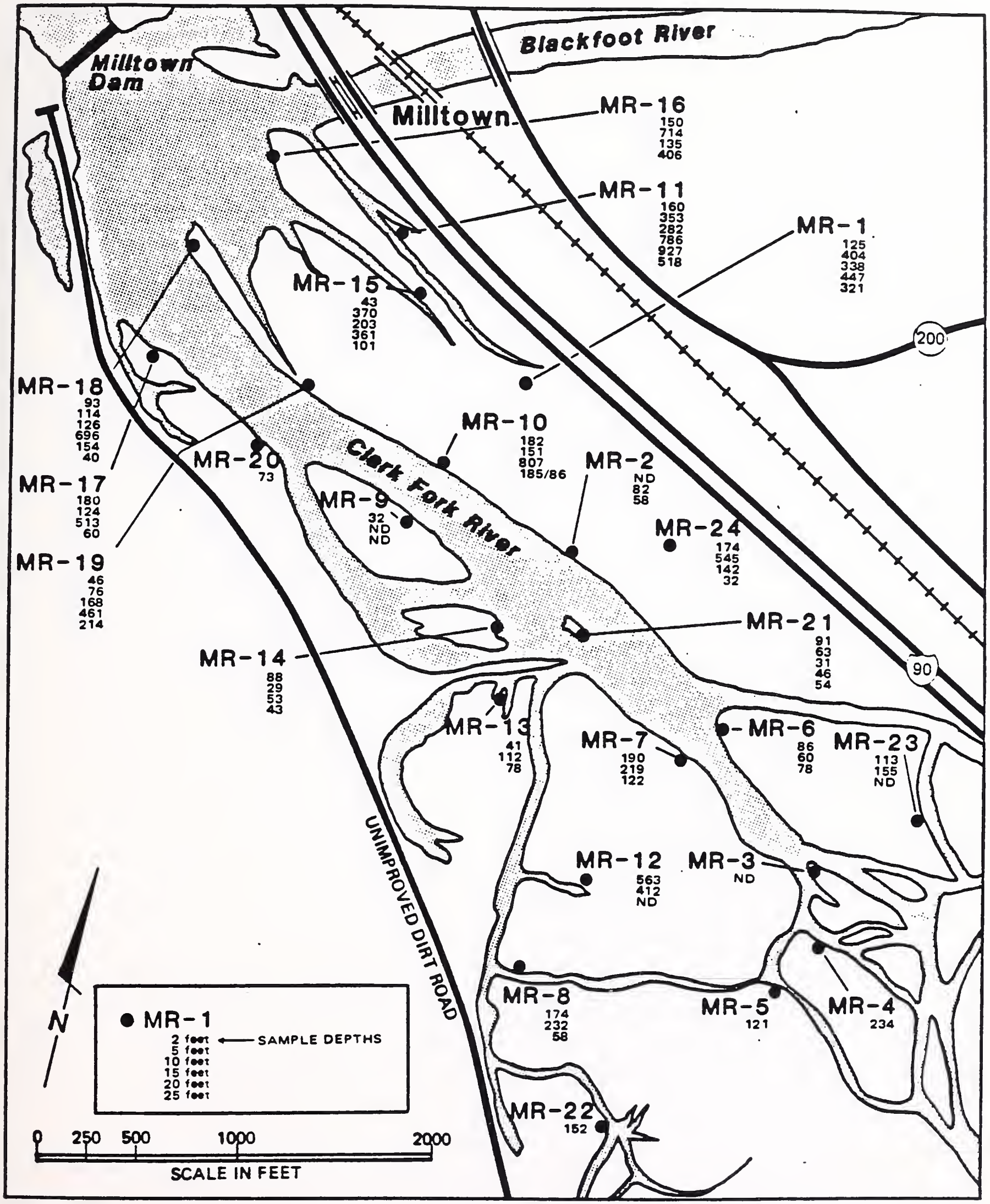


Figure C-2: Area and Vertical Distribution of Arsenic in Subsurface Sediments (mg/kg) Milltown Reservoir. (Source: HLA, 1986).

CDM

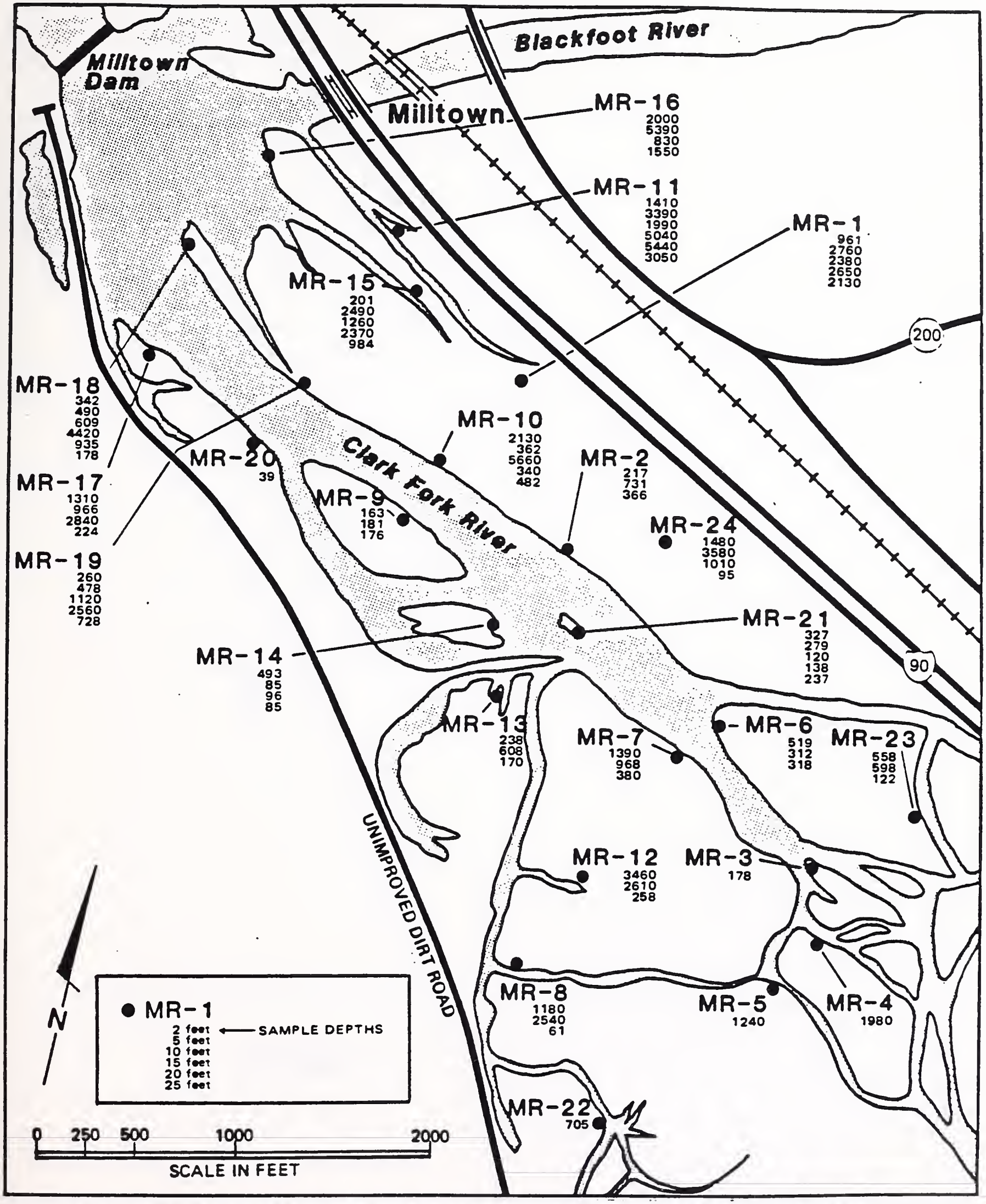


Figure C-3: Area and Vertical Distribution of Copper in Subsurface Sediments (mg/kg) Milltown Reservoir. (Source: HLA, 1986).

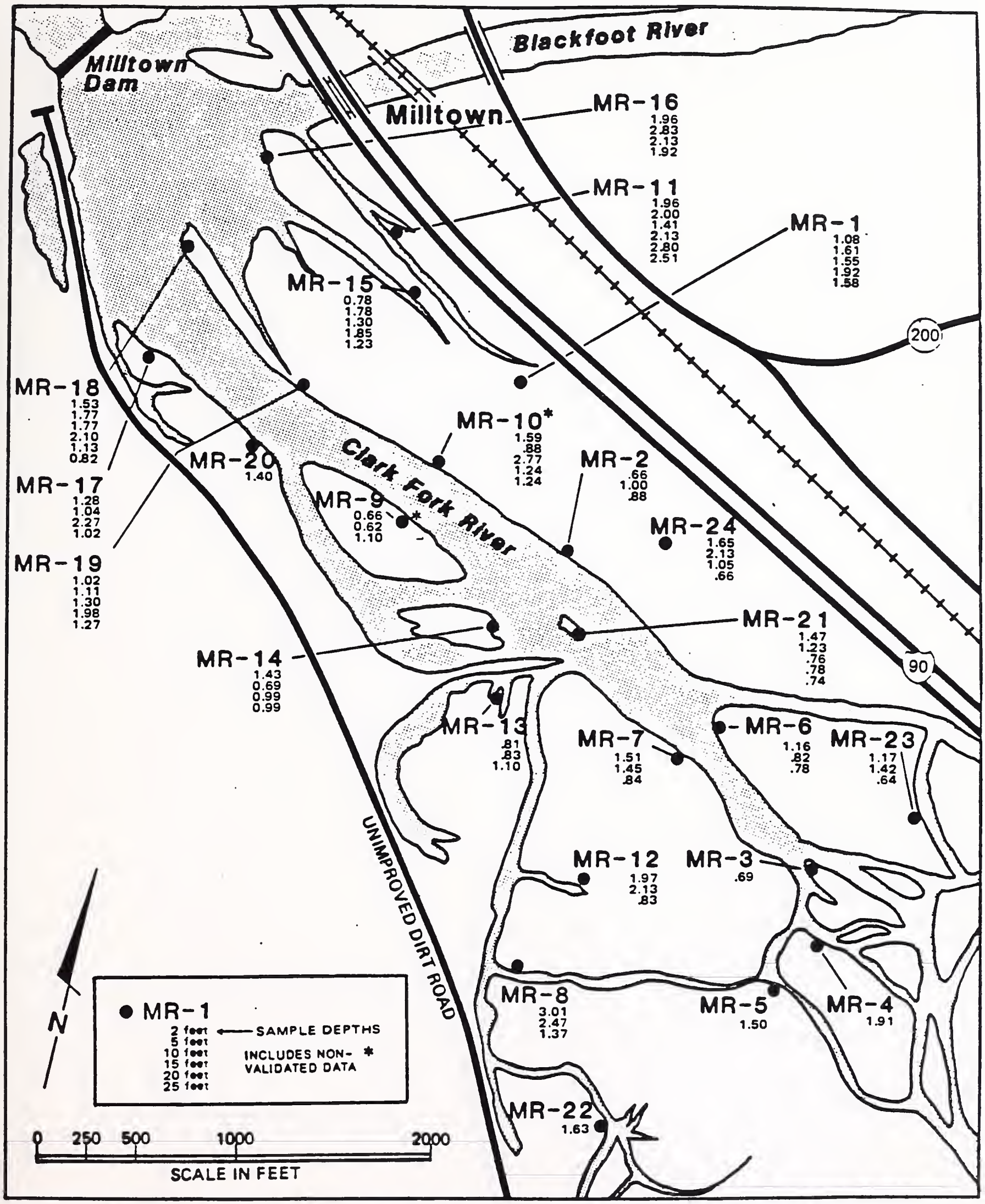


Figure C-4: Area and Vertical Distribution of Iron in Subsurface Sediments (%) Milltown Reservoir. (Source: HLA, 1986).

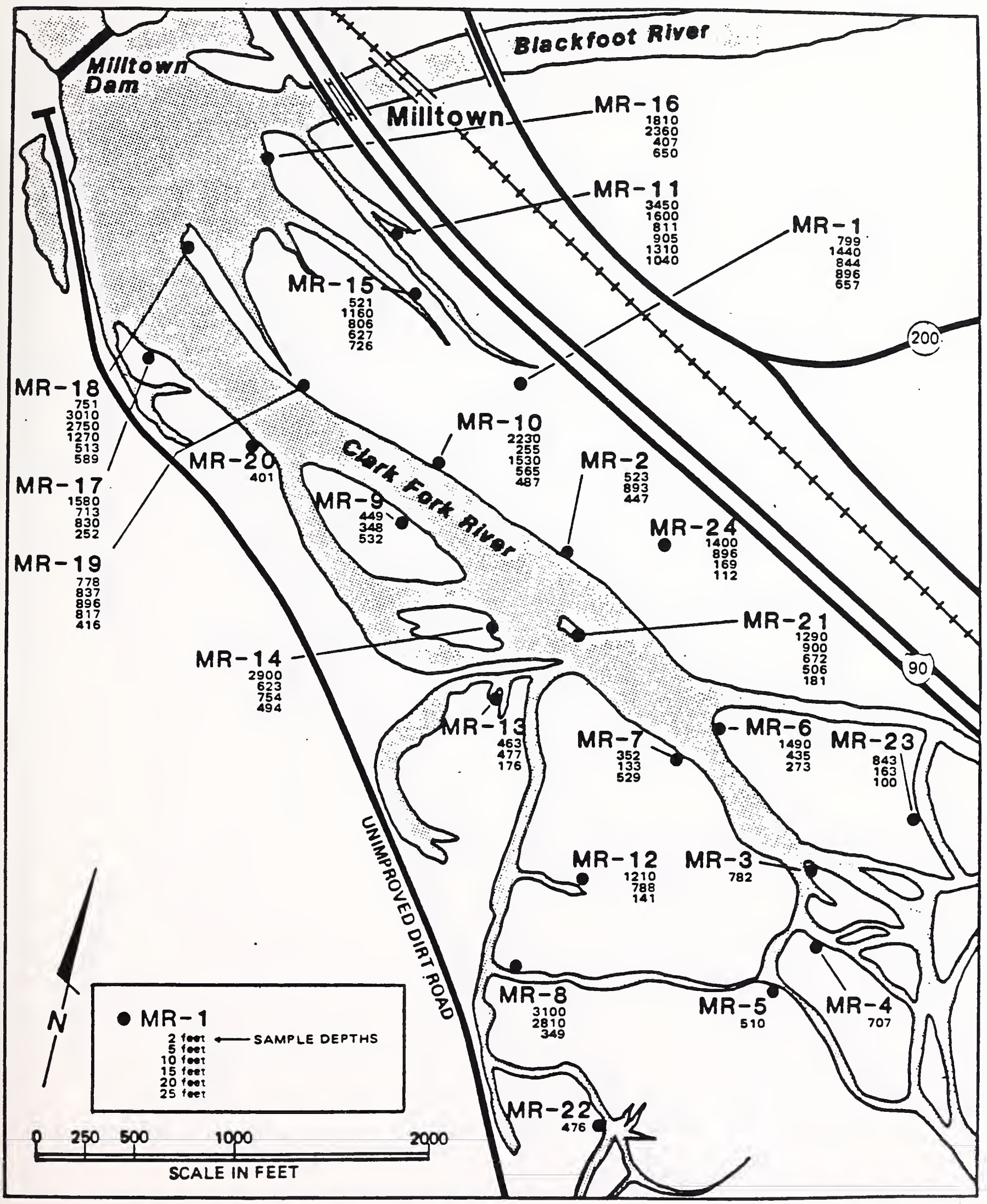


Figure C-5: Area and Vertical Distribution of Manganese in Subsurface Sediments (mg/kg) Milltown Reservoir. (Source: HLA, 1986).

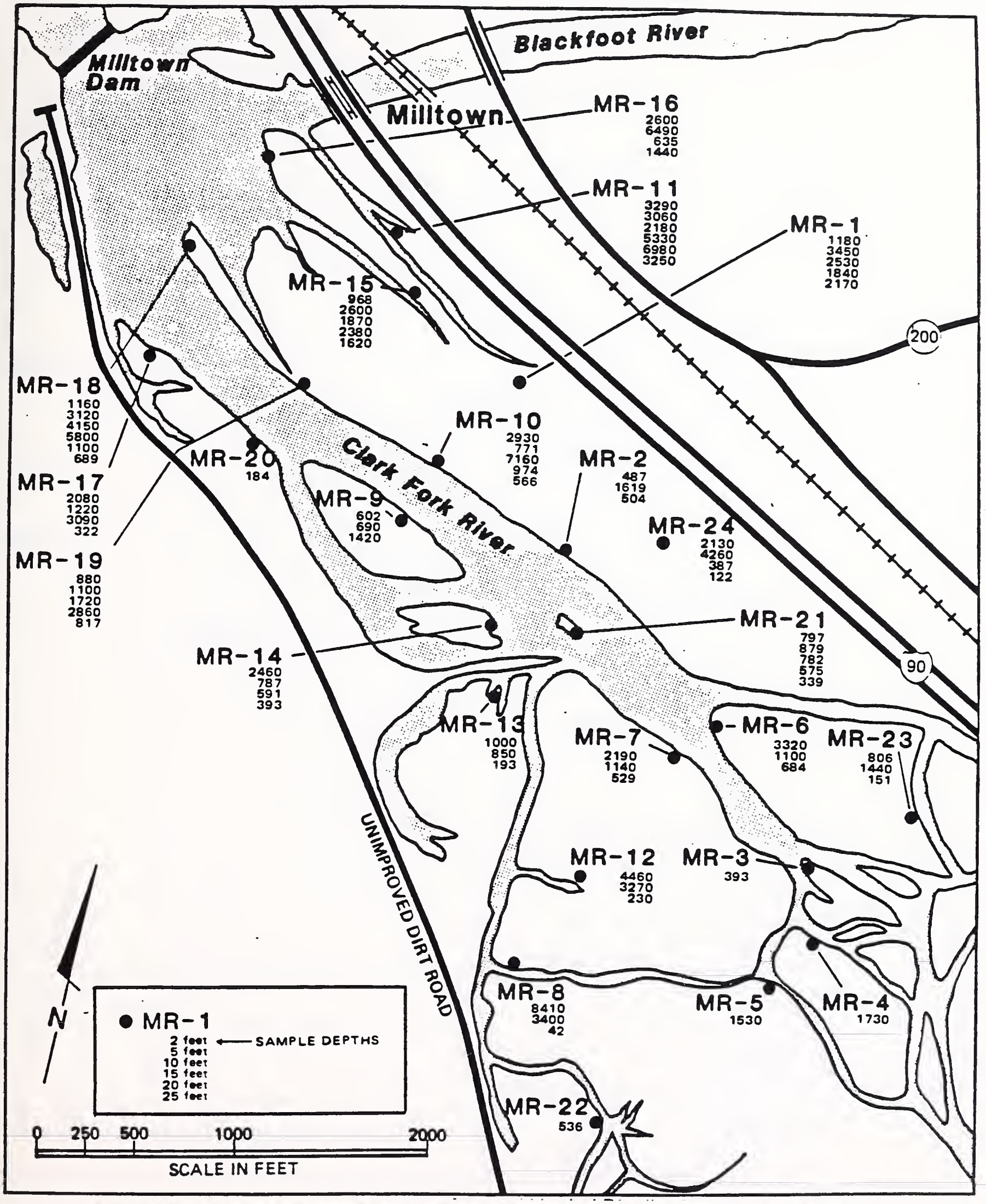


Figure C-6: Area and Vertical Distribution of Zinc in Subsurface Sediments (mg/kg) Milltown Reservoir. (Source: HLA, 1986).

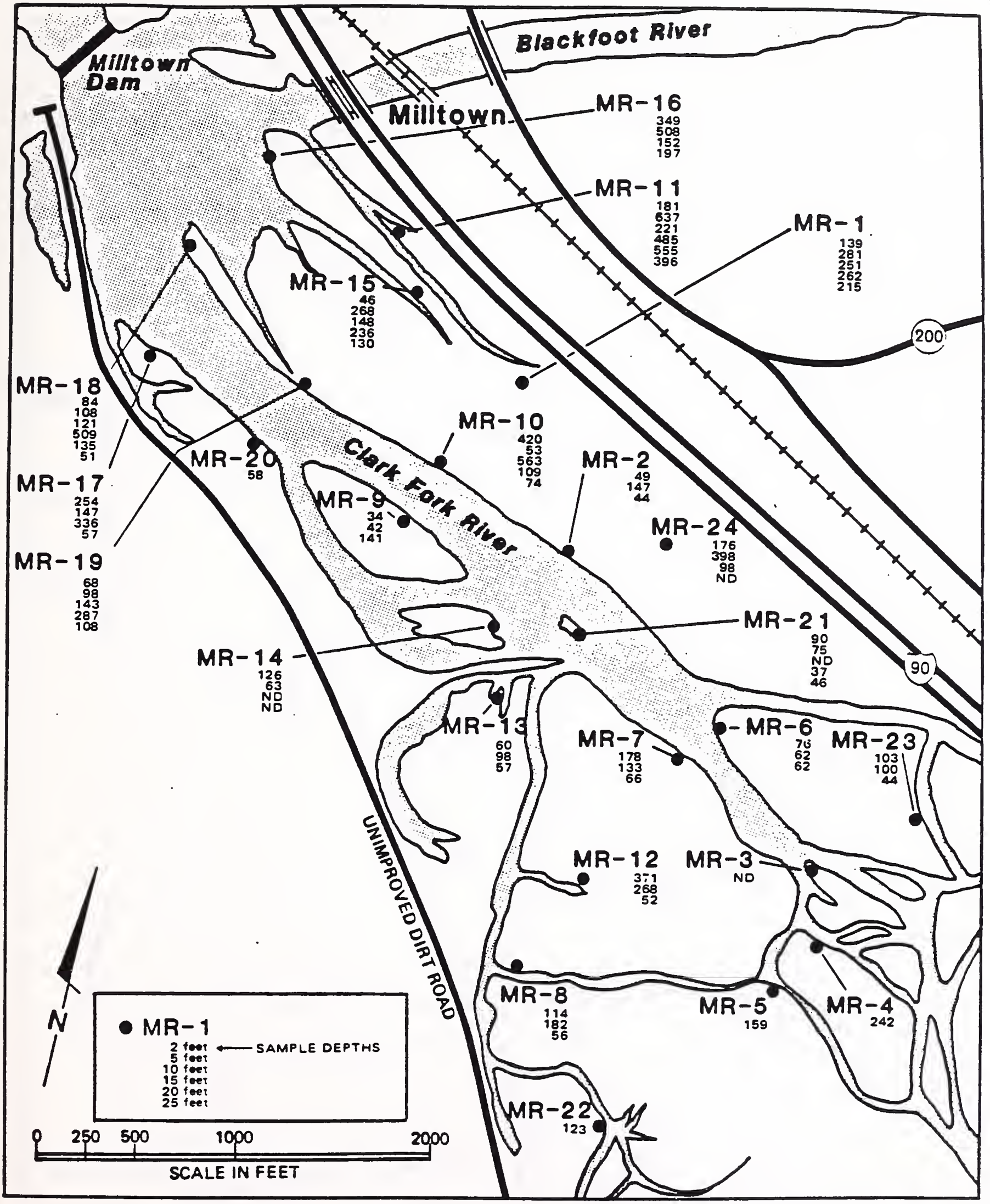


Figure C-7: Area and Vertical Distribution of Lead in Subsurface Sediments (mg/kg) Milltown Reservoir. (Source: HLA, 1986).

CDM

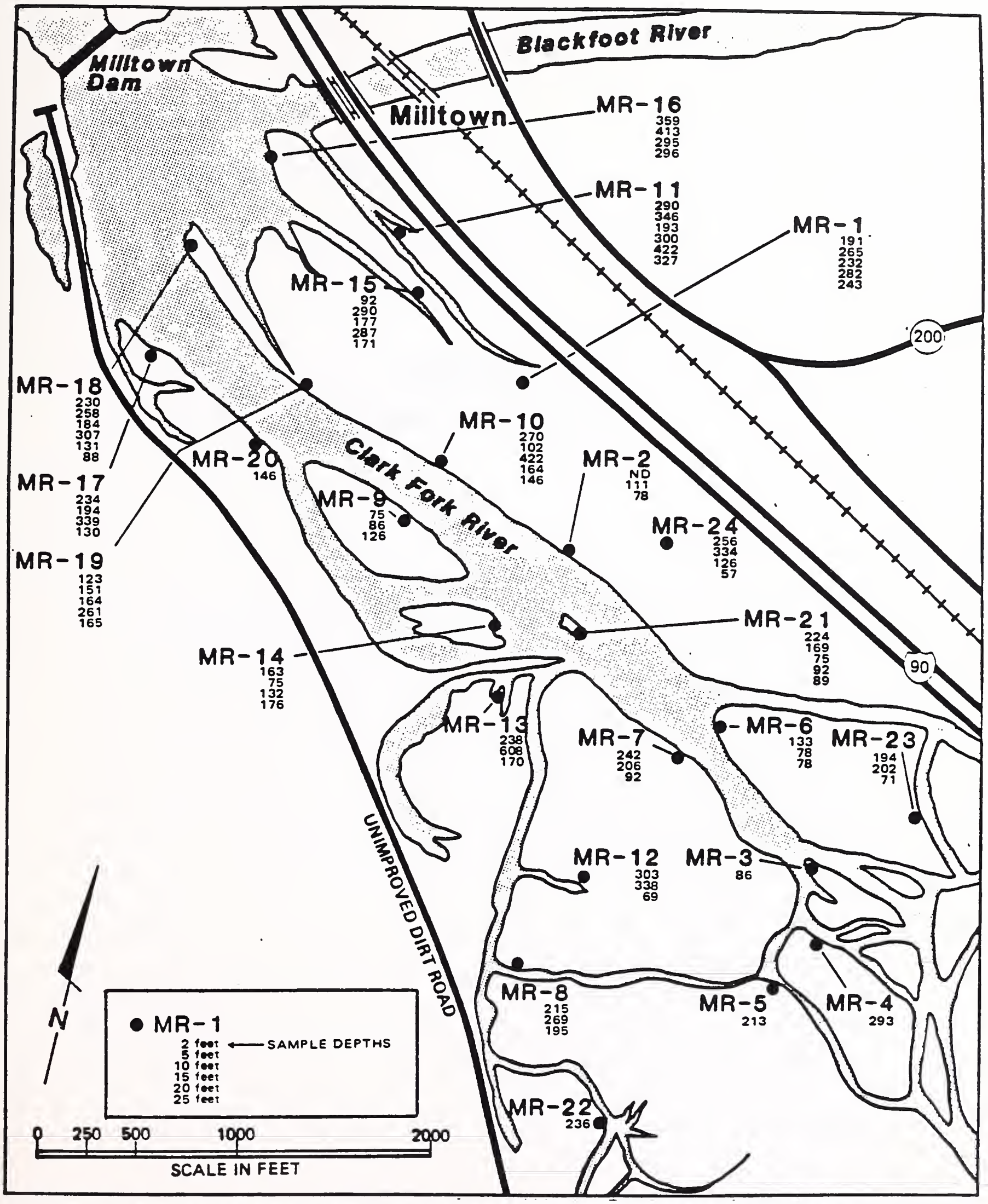


Figure C-8: Area and Vertical Distribution of Barium in Subsurface Sediments (mg/kg) Milltown Reservoir. (Source: HLA, 1986).

CDM

APPENDIX D

PRELIMINARY ARARs ANALYSIS

APPENDIX D

D.1 POTENTIAL STATE CONTAMINANT-SPECIFIC ARARs

In the vicinity of the Milltown Reservoir, the Clark Fork is rated as Class B-1 according to the Montana Water Quality Act. This classification is generally defined as follows:

> "Suitability for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply."

With regard to toxins, the following additional provisions apply:

> "Concentrations of toxic or other deleterious substances which would remain in the water after conventional water treatment must not exceed the maximum contaminant levels set forth in the 1975 National Interim Primary Drinking Water Standards (40 CFR Part 141) or subsequent revisions or the 1979 National Secondary Drinking Water Standards (40 CFR Part 143) or subsequent revisions. The maximum allowable concentrations of toxic or deleterious substances also must not exceed acute or chronic problem levels as revealed in bio-assay or other methods. The values listed in EPA water Quality Criteria documents (Federal Register Vol. 45, No. 231, Friday, November 28, 1980, pages 79318-79379) shall be used as a guide to determine problem levels unless local conditions make these values inappropriate. In accordance with Section 75-5-306(1), MCA, it is not necessary that wastes be treated to a purer condition than the natural condition of the receiving water."

This classification considers growth and propagation of salmonid fishes and associated aquatic life to be a concern. Although there are a variety of factors which could be influencing trout populations in the Clark Fork, ambient metal concentrations are an important factor and must be considered in order to protect or enhance fisheries resources at the Milltown site.

D.2 POTENTIAL FEDERAL ARARs

A preliminary list of Federal contaminant-specific ARARs for the Milltown Reservoir Sediment site are described below, and summarized in Table 5-2.

1. Maximum Contaminant Levels for Drinking Water

The Federal Safe Drinking Water Act provides for the establishment of drinking water standards for public water systems. These standards are "applicable" only to public water systems as defined by the Act and regulations. However, they may be considered "relevant and appropriate" as ARARs for potential ground water exposure via drinking water [U.S. EPA, Superfund Public Health Evaluation Manual (Oct. 1986)]. The Clark Fork downstream of the Milltown Reservoir provides the recharge for the sole source aquifer for Missoula. Therefore, drinking water standards are considered ARARs for the site.

The primary "maximum contaminant levels" or "MCLs" for organic and inorganic chemicals are considered ARARs (CERCLA Directive 9234.0-05). Primary MCLs are enforceable standards establishing maximum permissible levels of contaminants in drinking water. See 40 CFR § 14.2 (1986). These standards are health-based, but have an economic component. See 42 USC § 1401(1)(C). Primary MCLs are currently set for the following inorganic chemicals: arsenic, barium, cadmium, chromium, fluoride, lead, mercury, nitrate, selenium, and silver. In addition, RCRA required levels for release from permitted TSD facilities are identical to the MCLs. The applicable MCLs for the site includes arsenic at 50 µg/l.

The Safe Drinking Water Act also provides for establishment of secondary MCLs. These are designed to "control contaminants in drinking water that primarily affect the aesthetic qualities relating to public acceptance of drinking water." 40 CFR § 143.1 (1986). The regulations noted that secondary MCLs "in the judgment of the Administrator (of EPA) are requisite to protect the public welfare." 40 CFR § 143.2(f). Federal secondary MCLs are set for chloride, color, copper, corrosivity, fluoride, foaming agents, iron, manganese, odor, pH, sulfate, total dissolved solids, and zinc. 40 CFR § 143.3.

2. Federal Ambient Water Quality Criteria

Section 304(a) of the Clean Water Act, 33 U.S.C. § 1314(a) (1982), requries EPA to develop water quality criteria related to protection of human health and aquatic life. EPA has developed criteria for numerous substances. The federal water quality criteria are not legally enforceable and are therefore not

"applicable" to the cleanup. However, they may be considered "relevant and appropriate" under the circumstances of the release.

Under Section 121(d)(2)(A) of SARA, the remedy selected must "require a level or standard of control which at least attains ... water quality criteria established under Section 304 or 303 of the Clean Water Act, where such ... criteria are relevant and appropriate under the circumstances of time release or threatened release." SARA further provides that "(i) in determining whether or not any water quality criteria under the Clean Water Act is relevant and appropriate under the circumstances of the releases, (EPA) shall consider the designated or potential use of the surface or ground water, the environmental media affected, the purposes for which such criteria were developed, and the latest information available." (Section 121(d)(2)(B)(i) of SARA.)

EPA has determined that the ambient water quality criteria for acute and chronic toxicity to fresh water aquatic life and to humans for aluminum, antimony, arsenic, cadmium, copper, lead, silver, and zinc are relevant for the Milltown Reservoir Sediment site.

3. Clean Air Act

The Primary and Secondary National Ambient Air Quality Standards ("NAAQS") for Total Suspended Particulates ("TSP") found at 40 CFR Sections 50.6 and 50.7 are identified in the NCP as potential Federal ARARs (50 Fed. Reg. 47949, November 20, 1985). On July 1, 1987, these standards were replaced by the new PM_{10} national primary and secondary NAAQS for particulate matter of less than or equal to 10 micrometers in diameter (see 50 Fed. Reg. 24634, July 1, 1987). The new "PM_{10}" standards are Federal ARARs for addressing particulate matter in fugitive dust emissions that might originate from exposed dried sediments from the Milltown Reservoir Sediment site. The Primary and Secondary National Ambient Air Quality Standards for lead found at 40 CFR Section 50.12 are also ARARs for the site. See subparagraph 121(d)(2)(A) of SARA.

The Primary and Secondary NAAQS for particulate matter and lead are set forth in the following table and will be considered Federal ARARs for the Milltown Reservoir Sediment site:

Primary and Secondary NAAQS

Particulate	150 $\mu g/m^3$, 24 hour average 80 $\mu g/m^3$, annual arithmetic mean
Lead	1.5 $\mu g/m^3$, max. arithmetic mean over a calendar quarter

No primary or secondary NAAQS exist for arsenic or cadmium.

LOCATION-SPECIFIC ARARs

Physical characteristics of the site influence the type and location of remedial responses considered. The location-specific ARARs identified for the site in Table 5-3 establish consultation procedures with Federal agencies and may impose constraints on the location of remedial measures or require mitigation measures.

The location-specific ARARs for the Milltown Reservoir Sediment site relate to fish and wildlife, wetlands, floodplains, and work in navigable waters. The location-specific ARARs influence the type and location of remedial alternatives developed for the site.

1. Fish and Wildlife

   The Fish and Wildlife Coordination Act requires EPA to coordinate with Federal and State agencies if the remedy would modify any stream or water body. If any remedy selected involves modification of the Clark Fork River, EPA will work with these agencies to provide for protection of fish and wildlife.

2. Floodplains

   Any treatment or sediment disposal facilities constructed will be situated out of the floodplain. Requirements of the Executive Order on Floodplain Management are applicable to this site.

3. Wetlands

   The Executive Order on protection of wetlands is applicable for this site.

4. Work in or Affecting Navigable Waters

   If the remedy selected for the site involves work in or affecting waters of the United States, EPA will follow all relevant ARARs under Section 404 of the Clean Water Act.

ACTION-SPECIFIC ARARs

The action-specific ARARs for the site deal with requirements for the degree of treatment for wastewater if discharged and disposal of untreated

and treated sediments. In addition to being described below, action-specific ARARs are summarized in Table 5-4.

1. National Pollution Discharge Elimination System (NPDES)

During remediation, CERCLA 121(d) requires that remedial activity generated discharges meet the pollutant limitation and performance standards included in the Clean Water Act. The wastewater treatment technology proposed in response alternatives for CERCLA sites are required to meet the equivalent of best conventional pollutant control technology (BCT)/best demonstrated available technology economically achievable (BDAT). EPA has promulgated the technology-based requirements through effluent limitation guidelines for specific categories of industries with ongoing commercial activities, which are then transferred into specific discharge limits by NDPES permit writers. Where effluent guidelines for a specific industry or industrial category do not exist, e.g., Superfund sites, technology-based treatment requirements equivalent to BCT/BAT will be determined by EPA on a case-by-case basis using best professional judgment in accordance with CWA 402(a)(1)(B) and 40 CFR 125.3(c)(2). These requirements would continue to be enforced at the completion of the remedial action during the operation and maintenance of the remedy.

The NPDES regulations governing the methods for imposing BCT and BAT treatment require that EPA consider the appropriate technology for the category or class of point sources of which the applicant is a member (40 CFR 125.3(c)(2)(i)). The previous operations responsible for deposition of sediments at the Milltown Reservoir sediment site were extraction, beneficiation, and processing of metals. The applicable effluent limitations for these activities are found in 40 CFR 440 which sets discharge limitations. However, Part 440 is neither applicable nor relevant and appropriate because these requirements pertain solely to operation and not closure of a mine site.

2. Solid Waste Disposal Act (SWDA)

General RCRA Requirements - The Solid Waste Disposal Act was amended by the Resource Conservation and Recovery Act (RCRA) to control hazardous substances. The provisions of RCRA pertinent to the Milltown site have been promulgated under 40 CFR Parts 257, 260, 261, 262, 263, 264, 268, and 280. EPA has determined that the above regulations are "applicable" to RCRA characterized and listed hazardous wastes (40 CFR Part 260) which either (1) were disposed at a site after November 19, 1980, or (2) the CERCLA remedial action consists of treatment, storage, or disposal as defined by RCRA (40 CFR Part 264). In addition, these regulations are "relevant and appropriate" to RCRA hazardous wastes disposed at a site prior to November 19, 1980.

Some of the contaminants of concern (arsenic, cadmium, and lead) at the Milltown Reservoir Sediment site are listed in Appendix VIII of RCRA (40 CFR Part 261, App. VIII) and the wastes were disposed on-site prior to November 1980, for any future remedial action involving treatment, storage, and disposal as defined by RCRA. These regulations are "relevant and appropriate" for any other activities resembling RCRA regulated activities. However, two important items related to the applicability of RCRA must be noted:

- Currently, "waste from the extraction, beneficiation, and processing of ores and minerals" (40 CFR Part 261.4, 6, 7) is excluded from regulation under RCRA.

- MPC (1985) Evaluations of sediment samples from the Milltown Reservoir site included measurements of Extract Procedure (EP) toxicity. The results indicate that the materials were not EP toxic; therefore, the sediments are not RCRA characteristic wastes. Confirmation of this result should be obtained for the FS.

RCRA permits are not required for portions of CERCLA actions taken entirely on-site. Therefore, administrative RCRA requirements (i.e., reporting, record keeping, etc.) are not "applicable or relevant and appropriate" for on-site activities. However, all hazardous wastes disposed off-site are required by CERCLA 121(d)(3) to be in compliance with all pertinent RCRA requirements.

RCRA Storage Requirements - EPA defines storage under RCRA to be a RCRA hazardous waste which is held for a temporary period, at the end of which the hazardous waste is treated, disposed, or stored elsewhere (40 CFR 260.10). The RCRA requirements are "applicable" to activities of this type. In some cases the hazardous waste may first become subject to regulation as a result of the action taken at the cleanup site. If the party(s) conducting the cleanup are considered the generators of the waste, 40 CFR 262.34 provides that, under certain conditions, the waste may be stored for 90 days before the RCRA Part 264 requirements become "applicable." Otherwise, the RCRA requirements are "relevant and appropriate."

RCRA Treatment Requirements - CERCLA 121 establishes the requirements for remedial actions involving treatment that such actions permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substance, pollutants, and contaminants at the CERCLA site. The RCRA requirements are "applicable" at the site if (1) the waste is hazardous, (2) the treatment complies with the RCRA definition contained in 40 CFR 260.10, and (3) the special jurisdictional prerequisites in the pertinent subpart for each category of treatment are satisfied. Otherwise, the RCRA requirements are "relevant and appropriate."

RCRA Disposal Requirements - EPA has defined disposal under RCRA to be the movement (grading, excavation, etc.) of a RCRA hazardous waste originally disposed before the 1980 effective date of RCRA from within a "unit area of contamination" and placed in another location outside the "unit area of contamination." The RCRA requirements are "applicable" to activities of this type, and "relevant and appropriate" to similar activities.

In the case of the Milltown Reservoir Sediment site as with many CERCLA sites, there is no defined RCRA type "unit," but rather an "area of contamination" with differing wastes types and levels of contamination. Therefore, excavation, treatment, and encapsulation conducted within the site would be within the "area of contamination" and not conform to the RCRA definition of disposal. The RCRA requirements are not "applicable." Any transport of wastes off-site do fall under the definition; the RCRA requirements are "applicable" in this case. The RCRA requirements are "relevant and applicable" for on-site activities. Using the disposal requirement in this manner requires the "design and operating" RCRA requirements. These include design requirements for landfills (including waste piles during construction), surface impoundments, and land treatment units.

Land Disposal Requirements - The disposal of RCRA hazardous waste during the course of remedial action may also be subject to the special restrictions on land disposal of hazardous waste established by the Hazardous and Solid Waste Amendments of 1984 (HSWA). According to HSWA, all RCRA hazardous wastes are to be reviewed by EPA to determine if they should be banned from land disposal. Banned waste cannot be placed in or on the land unless they have been first treated to levels achievable by best demonstrated available technology (BDAT) for each hazardous constituent in the waste.

EPA has defined placement and disposal to be identical. Whether the land restrictions are "applicable" or "relevant and appropriate" depend upon the disposal factors previously discussed. Any on-site excavation, treatment, or encapsulation of waste at the Milltown Reservoir Sediment site does not follow the RCRA definition of disposal. Therefore, placement does not occur and the land disposal restrictions are not "applicable" nor are they considered "relevant and appropriate" until the EPA promulgates BDAT standards for RCRA soil and debris. However, any waste transported off-site for disposal does comply with the RCRA definition; the RCRA requirements are "applicable" in this case unless the waste is disposed prior to November 8, 1988. HSWA includes an exemption from the land disposal restrictions for RCRA soil and debris collected pursuant to actions conducted in accordance with 104 and 106 of RCRA. These provisions provide an exemption to the law until November 8, 1988.

3. Surface Mining Control and Reclamation Act (30 USC Sections 1201-1328) and Implementing Regulations

The Surface Mining Control and Reclamation Act (SMCRA) and associated regulations are enforced by the Office of Surface Mining Reclamation and Enforcement (OSMRE). Regulations pursuant to SMCRA concern reclamation of coal mines and are, therefore, not applicable to the Milltown Reservoir Sediment.